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No 4 Edward

H: Mackleraith M

PHYSICAL
ESSAYS
On the PARTS of the
HUMAN BODY
AND
Animal Oeconomy.

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Phyſico-Anatomical
ESSAYS
Upon the PARTS of the
HUMAN BODY.

REMARK I. *The Structure of the Bones.*

THE Bones, ſays *Gagliardi*, beſides their Solidity, have a ſpongy and reticular Subſtance; there is, as we ſhall hereafter obſerve, a Membrane that forms Veſicles in the Interſtices.

The hard Subſtance is compoſed of ſeveral *Laminæ* placed in order the one on the other; in the longer Bones the external *Lamina* is removed from the others at the Extremities; that which follows is in like manner remov'd, but is ſhorter than the former: this alſo happens to the reſt: The Heads of Bones when they are longitudinally divided, reſemble a Racket; hence we ſee what occaſions the Bulk of oſſeous Extremities.

The ſpongy Subſtance is nothing but a Texture of many oſſeous *Laminæ*, which by croſſing one another form ſmall Cellules: theſe *Laminæ* of the hard Subſtance by their Diſperſion produce this ſpongy Subſtance: This is the Reaſon why we obſerve it in the Heads of Bones.

The reticular Subſtance or Network is a Compoſition of ſmall Filaments croſſing one another; theſe ſmall Threads ariſe from the ſpongy Subſtance in which they are mix'd, and are found in the Cavities of Bones for the Preſervation of the Marrow.

The Interſtices between the ſmall Filaments of the Network are lined with a Membrane that forms there the Veſicles: it is in theſe Veſicles, which reſemble a Bunch of Grapes, that the Blood-Veſſels filtrate an oily Subſtance call'd Marrow.

In the round and long Bones there are theſe three Sorts of Subſtances, of which we have already treated; but in the flat Bones we only find the hard and ſpongy Subſtance, which in Bones of the Head is call'd *Diploe*.

There is not ſuch a great Difference between the hard and ſpongy Subſtance as immediately appears; for if we calcine the Bones, it appears that their moſt ſolid Part is nothing but a Heap of ſmall Cellules; a harden'd Matter fills thoſe Cellules, and a ſoft Subſtance flows in the ſpongy Texture. The Oil which is contained in the Interſtices of the *Rete* or Network, is alſo divided in the Cellules of the ſpongy Subſtance.

The Teeth are a Species of Bones; *Malpighi* has clearly diſcovered the Structure of thoſe in Oxen; but as for thoſe in Men we have no Obſervations that give us any great Inſight: there is a whitiſh Subſtance on the outſide, it is ſoft in a *Fœtus*, but in time it hardens like Stone; it is compoſed of perpendicular Filaments that appear on the Surface of the internal Subſtance: it is nothing but ſmall Veſſels wherein is depoſited the chalky Matter: Theſe Veſicles, when grown hard, reach the internal Subſtance, which appears to be a *Congeries* of Cellules, in which the Blood that comes from the Root of the Tooth circulates. Hence it is evident that the Teeth muſt appear black, when the white Subſtance is removed. This Subſtance may be deſtroy'd, either by external Cauſes, or when the Blood ceaſing to circulate, is corrupted, and corrodes the Enamel. That Part which forms the Root of the Tooth is truly oſſeous, according to the Obſervation of *Clopton Havers:* it is compoſed of bony *Laminæ*, as the other Bones: It was neceſſary for Maſtication that the Enamel ſhould be compoſed of a Subſtance harder than the reſt.

The Teeth have a Membrane that covers their Root; it riſes from the Membrane covering the Gums and lining the Mouth. There ſometimes appears at the Root of the Teeth a fleſhy Part like the Gums, in order that the Teeth may ſet the ſtronger. As for the *Perioſteum* that inveſts the *Os Maxillare* or Jaw-Bone, it is bent into the Sockets; on one Side it touches the Bone, on the other the fleſhy Part that covers the Teeth: when this fleſhy Part is wanting, it is join'd to the Membrane that covers the Roots, in ſuch a manner, that their Subſtance is blended together.

We ſhall ſee in *Neurology*, that there are ſmall Ramifications of Nerves that enter the Maxillary Bones, ſending ſmall Filaments to the Teeth; every Tooth receives a Filament: The Hole thro' which they enter is ſometimes viſible without the Help of a Microſcope: their Situation varies often, ſometimes it is found at the Top, ſometimes at the Sides. Hence we conclude, by what we have already obſerved, That, firſt, the Teeth can afford Pain: Secondly, if we preſs the Gums, it may be extended to the Nerve of the Tooth, becauſe their Membrane ſurrounds the Root. By this we may explain the ſetting the Teeth on Edge. Let us now return to the Bones.

There are in the Bones longitudinal and tranſverſal Pores viſible by Microſcopes; theſe Pores, according to *Clopton Havers*'s Opinion, admit of no Paſſage to the Veſſels; but the tranſverſal he thinks contain the Marrow; from them it glides into the longitudinal.

The ſanguinary Veſſels enter the Subſtance of the Bones in order to nouriſh them: we may obſerve certain Ramifications in their hardeſt Parts, they glide between the oſſeous *Laminæ:* The Veins do not accompany the Arteries as they do in the other Parts of the Body, they carry back the Blood by ſome other Means: Theſe Veſſels ſerve for the Nutrition of the Bones.

The Bones are only nouriſhed by a chalky Juice that theſe Arteries depoſite in the Cellules, which are between the oſſeous *Laminæ:* This Juice, continually preſſed by the Arteries, firſt extends the oſſeous Fibres, and conſequently lengthens the Bones, and makes them thicker. Secondly, by the Preſſure of the Fibres and Pulſation of the Arteries, the liquid Part of the chalky Juice is diſſipated, and the remaining Part hardens.

The Bones therefore ought to harden; if that Subſtance were to diſſolve, and the Blood were to inflate the Veſſels, ſo as to be diffuſed throughout the Cellules, the Bones would appear reddiſh and in a manner fleſhy.

In the Cavity of long Bones we find an oily Subſtance that fills it; it is filtrated in the Veſſels that penetrate the Bone, and are ramified in the Veſicles form'd by the Membrane that is inſinuated in the *Rete* or Network: It is in theſe Veſicles that have a Communication with one another the oily Subſtance forming the Marrow is depoſited.

The Marrow is ſurrounded by a Membrane that ſerves for a *Perioſteum* to the internal Bones; it is very thin, and is form'd by the Coats of the Arteries. *Clopton Havers* aſſerts that it appears red as Blood in certain Places. This does not proceed (ſays the ſame Author) from its proper ſanguinary Veſſels, but from Veins that creep along the Surface of the Marrow: This Membrane adheres to the Bones, firſt by ſmall Veſſels, ſecondly by ſmall Extenſions it ſends forth in the oſſeous Pores: Hence we ſee that the marrowy Juice can flow in the Subſtance of the Bones. We ought not therefore to be ſurpriz'd to ſee that the oily Subſtance tranſudes thro' the Bones ſeparated from dead Subjects. *Clopton Havers* obſerved ſmall Ducts that carried the oil into the Jointures. We have no certain Uſe for the Marrow.

The external Surface of the Bones is inveſted by a Membrane call'd *Perioſteum*; the Fibres which compoſe it are not twiſted one within another, but are placed one upon the other. This Membrane is ſmooth externally, rough internally, and adheres to the Bones by ſanguinary Veſſels and Filaments: Theſe Filaments are perhaps nervous, and are the Cauſe of Senſation in the Bones, as *Diemerbroek* obſerved. However, the *Perioſteum* has a vaſt Senſation as well as the Marrow-Membrane that lines it. Of its Uſes we will ſpeak hereafter.

REMARK II. *Upon the Skin.*

THESE are the Teguments which cover the Body, of which the *Epidermis* is the firſt, *i.e.* the Upper-Skin; it is form'd by the Product of the Tegument that it covers: The *Cutis* has Wrinkles accompanied with ſecretory and excretory Veſſels and nervous *Papillæ*. Theſe three

Productions dried fall upon one another in Scales: The Fluid that is exhaled from them by the Heat hardens thoſe Scales. This Opinion is conformable to the Diſcoveries made by the Microſcope, by help of which we ſee upon the Body a ſcaly Surface: When the Action of Bodies upon the Scales of the *Epidermis* is too violent, the ſoft Parts that unite it to the *Cutis* will be ſeparated from it: When theſe Scales are ſeparated, the Wrinkles and excretory Ducts of the *Cutis* or Skin will be more extended, and form another *Epidermis:* If we ſeparate this new *Epidermis* from the *Cutis* there will be form'd a third; and hence the Origin of Caloſities or Hardneſſes, which are nothing but Plaitings of many *Epidermides*. But we are to obſerve, that to form theſe Caloſities or Hardneſſes, the *Epidermis* muſt not be ſeparated entirely, for then the tranſpirable Matter or Sweat would riſe in Bliſters, which happens in Scaldings; the Force of the Fire hardens the *Epidermis*, and ſeparates it intirely from the *Cutis:* the tranſpirable Matter which riſes under it, and cannot paſs thro' the *Epidermis*, raiſes that Membrane and forms Bliſters. The Bliſters that are rais'd upon the *Epidermis* in *Exanthemata* or Efloreſcencies, may be explain'd almoſt in the ſame manner. The Part of the *Epidermis* which is ſunk into the large Canals of the Skin is ſeparated from the Sides of the Canals which it lines; being rais'd by the Force of the Fluids that preſs upon it, it obſtructs the Paſſage againſt thoſe Fluids; it muſt therefore form red Pimples when the Blood is thrown into thoſe Canals. Under this Membrane there appears the *Corpus Reticulare:* In order to form an Idea of it, we muſt remember, that under the *Cutis* at the Surface of the *Membrana Adipoſa*, we find Beds of Nerves which form a ſort of Membrane accompanied by Veins, Arteries, and Lymphatick Veſſels. Theſe Nerves riſe in Pyramids that pierce the Skin; when they reach the *Epidermis* they loſe that Membrane which lined them. This Coat is divided into many *Laminæ* that are fixed to the *Cutis*, and are united to thoſe that ariſe from the other nervous *Papillæ*. By this Union of ſmall *Laminæ* the *Rete* is form'd. The Nervous *Papillæ* paſs thro' theſe Holes, and meet at the two Sides of each Furrow of the *Cutis*, where they are ranged in parallel Lines: they are the Organ of Senſation by means of a greater or leſs Motion excited in thoſe *Papillæ*; the Nervous Fluid expanded thro' all the Parts of the Body gives more or leſs lively Senſations; and if one Part is harden'd it will have no Senſation, becauſe the Nerves are then depriv'd of their Motion.

There is a cutaneous *Rete* or Network form'd by Veſſels that creep upon the *Cutis*; theſe Veſſels for the moſt part receive nothing but the Lymph; and hence it is that the Surface of our Bodies is white. As for the *Moors*, this *Rete* is compoſed of larger Canals; and hence the Reaſon why it is fill'd with Blood, which being depriv'd of the aqueous and lymphatick Matter by Tranſpiration becomes blackiſh, and is the Cauſe of their Colour. There are People that are of a lively red, becauſe the Blood in the *Rete* or Network is not depriv'd of its Lymph: In a word, according to the Quality of the Blood or other Fluids that enter this *Rete*, the Body will appear of various Colours. We muſt not wonder that the Veſſels of this *Rete* are not of the ſame Bulk in different Perſons; becauſe they vary very much even in the ſame Body: In the Cheeks, for example, it is very large, which is the Reaſon that in the leaſt Exerciſe the Blood is propel'd in this *Rete* and reddens the Face. In certain Paſſions of the Mind, the nervous Juice flowing ſtrongly in the Nerves, preſſes the Arteries,

teries, and by that means propels the Blood in the lateral Canals that form the *Rete*; but if the Contraction were ſtronger, the Blood would even ceaſe to flow in the Veſſels where it did: hence we grow pale in great Paſſions. The ſame would happen if the Force of the Nerves ſhould ceaſe; for then the Heart would not drive the Blood in the Arteries: and this is what happens in Fear.

There appears under the Scales of the *Epidermis* an infinite Number of Holes: *Lewenhoek* has obſerved under the Scales of the *Epidermis* 125000 in the Space that one Grain of Sand could cover; but we cannot determine whether they are Pores or Extremities of Arteries. We can ſee plainly that there are very conſiderable Ducts which jut out of the glandular Bodies that are at the internal Surface of the *Cutis*. They have obſerv'd at the Extremity of the Fingers with a Microſcope, that the internal Sides of thoſe Canals are pierc'd with many Holes, which are in the middle of the Furrows. Let us ſee how the Separation or Secretion of the Fluids, Sweat and Perſpiration are perform'd: but let us firſt of all examine Secretions in general.

REMARK III. *Of Secretions in general.*

THERE is no Subject that has cauſed more Diſpute than the Filtration of the Fluids: Mr. *Leibnitz*, that eminent Philoſopher, found in all the Opinions inſurmountable Difficulties: but prejudiced Opinions are often the Cauſe of all imaginable Difficulties in the *Phænomena* that are look'd into: We ſhould find but few Difficulties in the Secretion, if our Minds were freed from falſe Suppoſitions. Many Fluids are ſecreted from the Blood, whereof the following are the chief: 1*ſt*, The Head is always moiſten'd by an oily and very fattiſh Subſtance, which we ſhall take notice of when we treat about the Teguments of the Skull. *2dly*, Behind the Ears, at the Place where they are join'd to the Head, there is a Humour ſtill thicker, more glutinous, but leſs oily than the precedent; but the Membrane that covers the *Scapha*, the *Concha*, and Eminencies of the broad Ear, are cover'd with ſmall Follicles that afford an oily Subſtance, but drier, which can be chang'd into a white, hard, ſcaly Subſtance. As for the internal Part of the auditory Canal, there appear little round Corpuſcles, from whence glides a ſort of liquid and tranſparent Balm, which being depoſited in the Paſſage of the Ear, becomes thick, yellow, and as bitter as Gall, crackles upon the Fire, and is enflam'd after the Crack. *3dly*, Upon the Face are filtrated Subſtances of various ſorts; there are Strainers affording an Oil that renders the *Cutis* or Skin ſmooth and poliſh'd: If we rub our Face with a black Piece of Woolen-Stuff, there will appear upon it white Spots of that Oil. Beſides, if we apply a clean and poliſhed Glaſs upon the Face, and examine that Part of it which has touch'd the Skin, there will be viſible thro' the Microſcope Drops of Oil: This Oil abounds pretty much under the Armpits and Point of the Noſe; but the Cheeks, Lips, and Skin which are under the Eyes, have deep *Lacunæ* that filtrate a thicker Matter, which iſſues out in the Form of a Worm when thoſe *Lacunæ* are preſſed, and make Spots if too long kept in theſe *Lacunæ*: if by the Preſſure theſe Follicles are emptied of their thick Matter, they afford, when compreſſed again, an unctuous and more ſubtile Fluid. *4thly*, The pituitary Membrane of the Noſe affords another Subſtance without Smell and Taſte, that is viſcous, and mixes with Water, which when dried, is chang'd into a ſort of hard Matter. *5thly*, Around the *Uvula*,

Uvula, Almonds, the poſterior Part of the Tongue, and in the *Larynx*, there is a Liquor filtrated, reſembling that we juſt now mention'd, but does not harden ſo eaſily. 6*thly*, In the *Aſpera Arteria*, and in the *Bronchæ*, there is ſuch another ſort of Liquor, but more diluted than the precedent. 7*thly*, The glandular Bodies of the *Oeſophagus* afford alſo a Liquor not very unlike this now mention'd, but is a little thicker, as appears by preſſing the *Folliculæ*. 8*thly*, In the Stomach and Inteſtines there appears a ſort of *Capſulæ*, that are ſometimes ſingle and ſometimes in vaſt Heaps: There is beſides this a Tuft, forming *Mamellæ* that reſemble the Fruit of an *Indian* Fig-tree, as *Ruyſch* expreſſes it: there is filtrated by means of theſe Organs a Fluid, which is very adherent to the internal Coat of the Stomach, and reſembles that of the *Oeſophagus* the ſame as that of the ſmall Guts; but in the Follicles of the *Colon* and *Rectum*, this Matter is thicken'd, and is in great Quantity. 9*thly*, The external Parts of the *Anus* admit alſo of Follicles that are ſurrounded by a ſtronger Membrane; there is gather'd a thicker Matter in that Part, and reſembles Wax waſhed with Water expoſed to the Sun, and by theſe means bleached. 10*thly*, In the Sinuoſities of the Groins and Buttocks there are *Capſulæ* like thoſe that are at the *Alæ* of the Noſe, which afford an unctuous Matter: There are beſides *Lacunæ* that have ſome Reſemblance to thoſe of the Head, and emit an Oil very different from that Wax before-mention'd. 11*thly*, Under the Armpits there is filtrated a yellowiſh Matter that has a very nauſeous Smell. 12*thly*, There is under the *Præputium* a Matter that has a very diſagreeable Smell, it is whitiſh, and Water can ſcarce dilute it; it is viſcid, and forms *Pelliculæ*. Perhaps this Matter, ſo different from all the reſt, proceeds only from the *Lacunæ* of the *Urethra*; for it is certain that it is wanting in thoſe who are circumciſed, and thoſe who are attacked with a *Paraphymoſis*; but in the *Epiphymoſis* there is a great Quantity of it diſcharged: beſides this, what *Tyſon* took for Glands round the *Glans*, *Ruyſch* has prov'd to be nothing but Eminencies form'd by nervous *Papillæ*. However, this Matter filtrated in great Quantity in hot Climates, produces Diſtempers that have given room for Circumciſion. This ſame Fluid is filtrated in the Parts of Women, *viz.* in the Cavity of the *Urethra*, at its Orifice and Parts adjoining; but it is very different from that which is filtrated in the internal Part of the *Vagina*. 13*thly*, There is a Wax filtrated in the Glands that border upon the Eyelids. 14*thly*, The other Secretions are pretty well known, I mean the Bile, the Urine, and *Succus Pancreaticus*, which differs but little from the *Saliva*. We ſhall ſee the Deſcription of the Bile and Urine in the Chapter concerning the Liver and Kidneys.

Theſe are Liquors very different from one another: The firſt Difficulty that occurs, is, Why the ſame Liquors ſhould always be filtrated in one Place, and never in another. Thoſe that have Parts of an equal Bulk ſhould be receiv'd in the ſame Strainers, and thoſe that have the ſame ſubtile Parts ſhould always accompany thoſe that have larger Parts.

There are Authors who were of opinion, that Nature in forming Bodies placed in each Strainer particular Juices that never mixed but with Juices reſembling them: The Bile, according to their Opinion, is prepar'd in the Liver, becauſe there is found in that *Viſcus* a Liquor which blends with it, and with no other; and therefore do not permit them to enter the ſame Receptacles in which they are contain'd.

Thoſe who are againſt this Opinion ſuppoſe that the Fluids that are filtrated are already form'd in the Blood: this is true, as we ſhall hereafter demonſtrate: But here are other Reaſons that will not eaſily be anſwer'd; in the Jaundice the Bile is diſtributed in all the Strainers, conſequently it is falſe that the Fluids filtrated in divers Places cannot be join'd to others; beſides, the Subſtance of the Bile is mixed in the Blood with the Bile and *Saliva*; Why ſhould it not be mixed in the Filtres? I ſhall be anſwer'd, That it changes: But in this manner you deſtroy the Hypotheſis built on this Opinion; *viz.* that the filtrated Fluids are form'd in the Blood. Beſides, if we mix Urine with the Bile ad *Saliva*, we find that theſe Liquors mix together; nay, we find no Fluid with which the Bile does not mix: In a word, ſince the Bile is diſtributed throughout all the Body, the Bile ſhould alſo be filtrated thro' all the Strainers.

Chymiſts have introduced the Ferments of their Laboratories into the Human Body; they believ'd that in each Strainer there were particular Ferments which chang'd the Parts of the Blood that flow'd thither. This Opinion is groundleſs, and is beſides confuted by what we juſt now ſaid; for the Bile that is diſtributed in the Body during the Jaundice, ſhould change all the Fluids into Bile, becauſe it is inſinuated in all the Strainers: thus the Jaundice would be incurable. I omit another Inconvenience ſufficient enough to demonſtrate the Abſurdity of this Opinion, *viz.* that they have recourſe to the Supreme Being to make him place Ferments in each Filtre. Other more philoſophical Writers were of opinion, that the Strainers were ſo many Sieves which permit but one ſort of Matter to paſs thro' them, and refuſe others: But what can be concluded from this ſort of Sieve? If the Holes are round and differ but in their Diameter,

meter, the ſubtile Parts of the Fluid that paſs thro' the ſmall Holes will alſo paſs thro' the larger; beſides the triangular, priſmatic, quadrangular, pyramidal Parts that require a Baſe of the ſame Length with the Diameter of the round Parts, and will be of the ſame Height; all theſe Parts, I ſay, will paſs thro' the ſame Hole; thus the Secretions will be all mixed; for Matter differs only but by the Configuration of its Parts: and we juſt now have obſerv'd, that Particles of divers Forms could paſs into the ſame Holes: It remains then, that we ſhould ſuppoſe theſe Holes diverſly form'd; but we cannot ſuppoſe this in the ſoft Tubes full of Juices, which being propel'd there by the Heart, ought all to take a ſpherical Figure, even if this were not ſo; ſpherical, quadrangular, triangular, pyramidal, pryſmatic and cylindrical Particles can paſs into the ſame Holes. We again ſee then the ſame Holes can receive all ſorts of Matter. I ſhall perhaps be anſwer'd, that this holds good only in Parts that have the ſame Altitude and Diameter: and ſuppoſe thoſe Parts paſſing thro' the ſame Holes to be of a greater Height, what will they gain by it? Let us take pryſmatic or cylindric Parts whoſe Height is greater than the Extent of their Baſe; I ſay, that thoſe Parts will not enter the Holes that have the ſame Figure; becauſe the Cylinder, for example, will paſs only when it is perpendicular to the Hole; but if it is oblique, it will not enter at all, the Degrees of Inclination it can take are infinite; ſo that there is but one Poſition that can favour the Entrance of that Cylinder, whereas there are infinite Situations that can hinder it, and conſequently the Cylinder will never enter: This is not all; this Opinion alſo ſuppoſes that the Parts of the Fluid that paſs thro' the Strainers have a Diameter equal to that of the Strainers, and a certain Form, which is abſolutely falſe; becauſe thoſe Parts can be divided again, and the Fluid not loſe its Form: Thus they can be adapted to all the various Forms of the Ducts. But let us proceed to the true Knowledge of Secretions.

Suppoſe a long Canal that has at its Sides many ſmall Tubes open exteriourly, What will happen if Water is forc'd thro' this Canal? The Side of that Canal muſt neceſſarily ſtretch; theſe Sides thus extended will preſs the Water, and oblige it to iſſue out thro' the lateral Tubes. This is what happens in the Human Body: the great Veſſels are like the Tube mention'd, they have at their Sides ſmall Tubes and Pores that end exteriourly or in Receptacles; when the Heart propels the Fluids, theſe Tubes muſt receive a Part of it, which they carry without or into thoſe Receptacles: it is therefore neceſſary that a Part of theſe Fluids be ſeparated from the Blood that circulates with it.

It remains therefore to find out how Parts of the ſame Subſtances are not ſeparated in all the Parts: Why, for example, is not the Bile ſecreted in the Kidneys? and why is not the Urine filtrated in the Liver? In order to determine this, we muſt firſt of all know whether theſe Fluids, *viz.* the Bile and Urine, *&c.* are in the Blood: 1*ſt*, The ſaline, oily, and aqueous Parts that compoſe theſe Fluids are in the Blood. 2*dly*, To form the Urine and Bile two principal things are requir'd; firſt it is neceſſary that the Salt of the Blood be alkalized, and be more volatile; ſecondly, the oily Subſtance muſt be attenuated and take the yellow Tinge, for Chymiſtry teaches us that theſe Alterations are produced by Heat and Motion; conſequently theſe ſame Changes muſt happen in the Blood where theſe two Cauſes are always found; nevertheleſs, as the Chyle is continually renew'd, and the red Globules with the Lymph are always found blended with the other Fluids, the Bile, and the other Fluids of Secretion are not as in their Strainers; the Bile, for example, is not bitter in the Blood, and the *Semen* has not all its Properties before it has been filtrated, for it does not give the ſame Strength in Eunuchs as in thoſe who are not ſuch.

We do not only prove by Reaſon that the Bile and Urine are form'd in the Blood, we can prove it alſo by Experience; for 1*ſt*, is it not plain that in Obſtructions of the Liver the Bile dyes the whole Maſs of Blood yellow? 2*dly*, if we tie the emulgent Arteries of a Dog, he vomits a Subſtance that taſtes and ſmells as Urine; all this muſt proceed, according to what we have already ſaid: the Subſtance of the Bile and Urine, retain'd in the Blood, receive there ſuch a Form by degrees, by means of the Action of the Heat; for they always are more alkalized, and become yellow and acrimonious when a Nurſe has a Fever; in this State it is fit to form the Bile.

By what we juſt now mention'd, it is plain that the Urine and Bile that are in the Strainers differ not from the Bile and Urine in the Blood, but by their greater or leſſer Quantity; for the Changes they undergo in the Strainers are reduced to theſe: they are ſeparated from the Blood, their Salts are more alkalized and volatilized, their Oil becomes yellower and ſeparates from the Water. In order better to underſtand why theſe two Liquors do not paſs thro' the ſame Strainers, we muſt ſtill farther examine whether they differ much at bottom. The Blood contains nothing but an Oil form'd into Globules, which forms the red Part; an oily Subſtance of different Configuration, and for that Reaſon is white, a *Sal ſalſum* join'd to the Oil; and laſtly clear Water, and perhaps Filaments of the ſolid Parts of the Aliments: theſe Subſtances more or leſs heated and agitated become yellow, loſe their aqueous Part, diſcharge their Salts, and thicken; and all this may happen according to the Largeneſs and Thickneſs of the Veſſels and Motion of the Blood: Hence it follows, that the Urine, Bile, and other Fluids that are filtrated in the animal Body, are the ſame in their *Principium:* they do not only differ in their Nature, but even the thickeſt Fluid is always mixed with the others in the Strainers; for the Subſtance of Perſpiration is aqueous, mixed with a ſmall Quantity of an oily Subſtance that becomes yellow and alkalized by Heat: The Urine contains a great Quantity of this yellowiſh Subſtance, and a great deal of Water, together with a vaſt Quantity of Earth and Salt. The Bile is but a Collection of yellow Matter depriv'd of its aqueous Parts, violently heated during its Courſe, which is very ſlow.

The Secretions being partly form'd in the Blood, and the ſubtile Parts being mixed with the more bulky, the larger or leſſer Canals, as alſo the greater or leſs Motions, will explain all the Difficulties of it. Here are a few Experiments concerning them: 1*ſt*, The Motion the Blood receives from the Heart is very ſlow in the Capillary Arteries, which are very diſtant; thus the viſcous Parts cannot be propel'd in the Strainers that are near the Extremity of thoſe Arteries. 2*dly*, The Capillary Arteries are ſmaller in one Part than in the other; they therefore will receive ſome Subſtances ſooner than others. 3*dly*, The Strainers that will receive a thick Subſtance will alſo receive a more ſubtile; thus will the Secretions be never pure. 4*thly*, Some Parts of the Blood are more ſubtile than others; thus ſome will paſs thro' thoſe Parts where others cannot. 5*thly*, There are Parts eaſier to be ſeparated than others; thus a violent Motion will ſeparate them, in order to drive them in certain Strainers, but a ſlow Motion will not be able to ſeparate them in ſuch a manner as to make them enter into Strainers of the ſame Diameter. *6thly*, Strainers which will receive Fluids that have been preſented to a vaſt many others ſmaller, will be filled with a thick Matter; this is the Caſe in the Liver. *7thly*, The Stay, Heat, Vicinity of the Heart, and Evaporation of the aqueous Matter will tinge the Fluids already filtrated with divers Degrees of Colour, Acrimony, and Thickneſs. *8thly*, The Fluids will be filtrated in a greater Quantity, according to the Number and Bulk of the ſecretory Tubes, and their Diſtance from the Heart. Theſe eight Principles will explain all the Differences that occur in Secretions; the Simplicity of thoſe Ideas ought to prefer them to all other Opinions: beſides, it is natural; for according to this Principle the firſt Secretion is perform'd, I mean that of the Chyle: the Aliments, when grinded and heated, are carried to the lacteal Veins; the Chyle, which is the moſt ſubtile Part, paſſes into thoſe ſmall Tubes, and the groſſer Subſtance follows the Courſe of the Inteſtines, where it takes divers Colours and Degrees of Acrimony, according to the Time it is lodged there, and the Fluid that moiſtens it: If in order to explain the Secretion of the Chyle and the Form the Excrements receive, we were to ſay that Nature placed a Ferment in the Inteſtines and lacteal Veins, it would be look'd upon as a ridiculous Opinion; it would be no leſs ridiculous than that Opinion we juſt now ſpoke of.

REMARK IV. *Of inſenſible Tranſpiration and Sweat.*

HAVING treated of Secretions in general, we ſhall make uſe of the ſame Principles in inſenſible Perſpiration, which is perform'd thro' the

Cutis and Lungs; the Force of the Heart that propels the Fluids of the Body, the Pores of the Skin and Lungs where thoſe Fluids terminate in great Quantity, the Extremities of the Arteries and excretory Ducts that open on the Surface of theſe Parts, prove the Exiſtence of that Evaporation which we call *inſenſible Tranſpiration*; but Experience confirms what we prove by Reaſon. When we breathe againſt a Looking-glaſs there appear Drops of Water collected upon its Surface; if we rub our Fingers upon Pewter or Silver, we leave behind Streaks of Moiſture; when we heat our Arm, and put it naked into a Glaſs-Bottle, we ſenſibly perceive in the Bottle little Drops; in Winter the Vapours that riſe from the Lungs condenſe, and form a ſort of Cloud; in Summer Mornings the cool Air produces almoſt ſuch another Condenſation: in a word, if we place ourſelves bareheaded nigh a Wall expoſed to the Heat of the Sun, we perceive a kind of Vapours which ariſe from the Pores of the Head: this Evaporation leſſens according to the Climates, Conſtitutions, and Occupations; for in proportion to the Condenſation and Rarefaction of the Cold and Heat, and the different Employments that produce the like Effects, the Heart will have more or leſs Force, and the Fluids find more or leſs Reſiſtance at their Egreſs from the Pores of inſenſible Tranſpiration. *Sanctorius*, in weighing himſelf in all the Circumſtances which could vary this Evacuation, found that of eight Pound of Aliment he loſt five by inſenſible Tranſpiration, and three by ſenſible Evacuations: this Difference only ariſes from this Cauſe, *viz.* that the Tubes which ſerve for inſenſible Tranſpiration are infinitely more in number than thoſe of the ſenſible Evacuation. But before we explain what *Sanctorius* ſays upon that Head, let us eſtabliſh ſome Principles.

1ſt, The Fluids are driven forwards by the Heart and Elaſticity of the Arteries; conſequently if theſe Forces diminiſh, leſs Matter will be perſpired; wherefore Grief and Fear, which decreaſe the Motion of the Heart, diminiſh Tranſpiration. *2dly*, If the Motion of the Heart and Force of the Arteries increaſe, the Fluids will be propel'd with greater Force: now this is what happens in Joy and moderate Exerciſe; for then the *Fluidum Nervoſum* is ſent into the Nerves in greater Quantity, and therefore Tranſpiration muſt be augmented. *3dly*, The Arteries are real Muſcles; ſo that when the Nerves ſend thither a great Quantity of their Fluid, they muſt cloſe their capillary Extremities; conſequently they muſt ſtop the tranſpirable Matter: and this is the Reaſon why violent Exerciſe hinders Tranſpiration. *4thly*, As ſoon as the external Parts are relaxed, the Blood ſent forth from the Heart will not find ſo much Reſiſtance there; conſequently the Fluids will be thrown thither in greater Quantities: hence it happens that hot Baths produce a more plentiful Tranſpiration; but if the Relaxation is too great, the Parts collapſed one upon the other, and preſſed by the external Air, would entirely ſtop the Pores; therefore Dropſical People do not tranſpire. *5thly*, If the Air becomes lighter it will preſs the external Veſſels leſs, conſequently the Fluids will find a leſs Reſiſtance; it will neceſſarily follow that Tranſpiration muſt be increaſed: but we are to obſerve, that there is a Neceſſity always for a certain Degree of Preſſure in the external Parts, in order that the Matter ſhould tranſpire eaſily; for the Arteries, dilated by the Action of the Heart, ought to be reſtored, ſo that the Fluids may be propel'd by their Sides: but without a certain Degree of Preſſure occaſion'd by the Gravitation and Elaſticity of the Air, the Sides of the Arteries would not approach one another near enough, and conſequently would not propel the Fluids, *6thly*, If the Air becomes heavier, it will ſtraiten the Veſſels, and thus the Blood will flow with greater Celerity, and by that means will heat the Solids, if the Rapidity augments. In proportion as theſe Veſſels are ſtraiten'd Tranſpiration will not diminiſh, provided that the Diameters of the Veſſels be large enough to give a Paſſage to the Particles of perſpirable Matter: thus we find that cold Baths may augment Perſpiration, after we come out of the Water; by the ſame Reaſon it will augment the Strength, ſince that depends upon the Action of the Solids and Velocity of the Fluids. *7thly*, Heat rarefies the Parts, and by this Rarefaction dilates the Tubes; thus we tranſpire more in hot Weather, but cold Weather diminiſhes that Heat and Rarefaction; conſequently the external Parts muſt of neceſſity approach one another by their Spring and by the Gravitation of the Air which compreſſes them: When they approach nearer to one another, the Fluids cannot iſſue out as before; thus Cold hinders Tranſpiration. *8thly*, If we diminiſh the Heat of the Blood, if we mix groſſer Matters or which are apt to thicken, or if we coagulate it, Tranſpiration will be diminiſhed; hence it is that Water in cooling and relaxing, the Chyle in dividing the Heat of the Blood and in thickning it, the Acids in coagulating and cooling it; I ſay by theſe means it is Perſpiration is hinder'd: but the Subſtances that have Motion, as thoſe that abound with Alkalies and much Fire, muſt cauſe a greater Tranſpiration. *9thly*, The Inteſtines and Kidneys are continually filtrating Fluids; when Tranſpiration abounds thro' the Skin, there muſt be leſs Matter carried to the Strainers: in the ſame manner, when the Juices are diſpos'd by the Kidneys and Inteſtines, Tranſpiration ſhould diminiſh; hence it happens that Diuretics and Purgatives diminiſh Tranſpiration: 'tis the ſame when we vomit, then the Liver, Pancreas, and Stomach are agitated by divers violent Motions that ſqueeze out a great Quantity of Matter. 10*thly*, The four Seaſons vary Tranſpiration and ſenſible Evacuations in a great degree; in Summer we tranſpire plentifully; in Autumn the Pores are conſtringed, and the tranſpirable Matter not finding a free Paſſage is evacuated thro' the Inteſtines; in Winter the Pores are ſtill more cloſed, conſequently the Urine, *Fæces* and *Saliva* are more plentifully diſcharged: laſtly, in Spring the Pores begin to open, and leſſen ſenſible Evacuations. 11*thly*, If the Air is moiſt, Tranſpiration muſt be diminiſhed, becauſe Humidity is always accompanied with Cold; hence it happens that we tranſpire leſs in a marſhy than in a dry Air; beſides, Humidity renders the Air much lighter; thus on one hand we ſee Tranſpiration check'd by Humidity, and on the other the Fluids flow ſlower in the Surfaces of the Body, ſince the Tubes are widened by means of the Lightneſs of the Air: this *Lentor* makes us more ſenſible of Cold, and leſſens Tranſpiration; this is what happens when it thunders. 12*thly*, As ſoon as the Body is uncovered, it always communicates its Heat to the Air that ſurrounds it, and is always in Motion; ſo that the Body ſoon grows cold; which is the Reaſon that if we ſleep without being covered, Tranſpiration muſt conſiderably diminiſh: the ſame would happen were we not covered in the Day-time, the circumambient Air would carry off a great deal of Heat: But when we are covered, it happens in the firſt place, that the igneous Particles are retained in the Clothes: ſecondly, Theſe Clothes compreſs the Veſſels, by which Compreſſion the Blood flows more rapidly, and by this means increaſes Heat; this Increaſe of Heat produces at laſt a more plentiful Tranſpiration: the Gravity of the Air may cauſe the ſame Effect: But if we are too much covered, the Veſſels would be in great Contraction, and the great Heat which would unexpectedly happen would diminiſh Tranſpiration. 13*thly*, If the large Veſſels that go to the *Cutis* were to be much inflated, they would compreſs the ſmall lateral Veſſels that diſcharge the tranſpirable Matter. This Reaſon, ſupported by the Action of the Nerves, which conſtringes the capillary Tubes, will demonſtrate why violent Exerciſe hinders Tranſpiration, and why the Parts that are bloated tranſpire but little. 14*thly*, There are Veſſels that open upon the Skin, ſome of which are larger than others: when the ſmall Canals have been contracted, the large ones that are yet open receive much more Fluid, and diſcharge it by Drops; and this is what we call Sweat, which (as we have ſhown) muſt neceſſarily appear in violent Exerciſes and Heat: But the Fluid that iſſues out in this manner thro' thoſe large Canals, is leſs in Quantity than that which paſſes by Tranſpiration. 15*thly*, In old Men theſe capillary Veſſels are ſhrunk up; conſequently they tranſpire much leſs: but the tranſpirable Matter which cannot paſs thro' the Skin, is thrown upon the Lungs and Inteſtines; which is the Reaſon that old Men ſpit much, and are troubled with the Looſeneſs; and that Winter, wherein is a great deal of tranſpirable Matter thrown upon the internal Parts, becauſe it cannot be diſcharged by Tranſpiration, is very dangerous for them, for it occaſions Catarrhs. 16*thly*, The Tranſpiration of the Lungs is extremely conſiderable; for all the Blood of the whole Human Frame each Day paſſes infinite times thro' this *Viſcus*, (which is a thin Contexture) as Cold is not felt there in the ſame manner as in the external Parts, the Heat, which always predominates there, ought to maintain Tranſpiration, and render it more copious in Winter. By this it appears of what Conſequence it is that the Air ſhould be warmed in the Mouth and Noſtrils before it enters the Lungs. 17*thly*, The Parts uncovered, always expoſed to the Air, tranſpire leſs; but when the Wind blows, Tranſpiration is diminiſhed conſiderably, becauſe the Wind applies ſucceſſively infinite Particles of Air to the uncovered Parts: hence it ariſes that fanning ourſelves diminiſhes Tranſpiration. 18*thly*, In Swellings, that which ſtops Tranſpiration moiſtens and ſoftens them; but if it be too long ſtopped, the Humour is increaſed, and the Veſſels are more inflated. 19*thly*, As there are Canals in our Body that diſcharge the Fluids outwardly, ſo there are ſome likewiſe that attract them as it were, and convey them inwardly; this is prov'd by Turpentine that we diſcharged by Urine, if we ſtay ſome time in a room which has been daubed over with this Fluid: Beſides, if we pour a Pint of Water into the *Abdomen* of a Dog, and cloſe the Wound immediately after, this Water is not to be found, it paſſes into the Veſſels.

By theſe general Explications we can account for all *Sanctorius*'s Experiments; there are many of them which we have explain'd in what we now have mentioned; but here are ſome others which are the chief: 1*ſt*, Tranſpiration is not alike at all times, during the four Hours after Meal it ſcarce amounts to a Pound, becauſe the Heat diminiſhing in the Blood in the Mixture of the Chyle, the Veſſels are cloſed; beſides, the Fluids become thicker by that Mixture: therefore we muſt wait till they are divided, that they may paſs. In the ſix following Hours the Fluid is divided, ſo that Tranſpiration amounts to 3 Pound: but after that plentiful Tranſpiration there remains a groſſer Part of the Fluid; thus in the following ſix Hours the perſpirable Matter amounts but to a Pound. *2dly*, Men are ſubject to a great Evacuation every Month, becauſe there is always ſome Fluid gathering; and after it has amounted to 2 Pounds, or thereabout, (which happens once in a Month) it goes off by Urine. 1. Let us ſuppoſe that the ordinary Force that propels the Urine is in proportion to 4. 2. That the Force neceſſary to cauſe a great Evacuation of this Matter is in proportion to 6. 3. That 2 Pound of Matter cauſes that Force to be equal to 6. 4. That when this Matter will be in ſuch a Quantity, we take 8 Pound of Aliment; then it will appear that there is above 7 Pound and a half of Matter which ſhould go off by Tranſpiration; but as this cannot be, the Fluids will act againſt the urinary Paſſages: And ſince we are to ſuppoſe that they have Force ſufficient to dilate them more than ordinary, they'll make that Dilatation; which being made, the Urine will paſs plentifully, and will carry off with it all that has been heaped up during a Month. The Evacuation is performed by the Kidneys rather than Inteſtines; becauſe the Blood propel'd by a greater Force, flows in a larger Quantity into the Strainers of the Kidneys; and when it acquires a certain Force, it opens the urinary Canals as Diuretics: theſe Canals being thus opened, a large Quantity of Matter is thrown there. *3dly*, Tranſpiration leſſened by degrees, increaſes by degrees alſo the Diameter of the Veſſels and Strainers of the Kidneys and Inteſtines; thus we perceive no Inconvenience: But the ſame is not in Tranſpiration which is of a ſudden checked by a cold Air; the Tubes in dilating ſuddenly muſt ſuffer by this Dilatation, and eſpecially in weak Bodies, where that Dilatation muſt be more conſiderable. *4thly*, After violent Exerciſe the cold Bath is pernicious, for then Tranſpiration is ſtopped, and the Bath ſuppreſſes the Sweat and occaſions a greater hindrance to Tranſpiration; beſides, the Veſſels are too diſtended during the Heat, and the Bath all at once ſhutting up the capillary Extremities, the Diſtenſion is increaſed. *5thly*, As moiſt Air is cold, we tranſpire better when the Air is dry; but when the Air is heated, as in Summer, we are very much fatigued, becauſe then there is a great Evaporation; for then the Veſſels are neither diſtended, nor the Nerves braced, which muſt neceſſarily cauſe a great Weakneſs. *6thly*, Light and little-nouriſhing Aliments are very aqueous, and conſequently muſt cauſe a greater Tranſpiration; but nouriſhing Aliments, *i. e.* thoſe that are more oily, and have more ſolid Parts, thicken the Blood, and muſt conſequently hinder Tranſpiration: As for fermented Aliments, they move the ſolid Parts, and ſtrengthen them, and therefore cauſe a greater Tranſpiration. *7thly*, When the Stomach is empty, we tranſpire but little, becauſe then the Strainers are not furniſhed with a ſufficient Quantity of Matter; and the ſame happens when the Stomach is too full, and by that means doth not digeſt: beſides, when the Stomach is thus fill'd and agitated, the Nerves of the whole Body are alſo mov'd, and by that means cloſe the capillary Extremities. *8thly*, We tranſpire better by eating twice than once a Day, for by eating much at a Meal (as we muſt do when we eat but once in a Day) the Veſſels ſwell prodigiouſly, and therefore the Heat is extinguiſhed in a greater degree; all which is an hindrance to Tranſpiration: beſides, after the large Tranſpiration, the Blood is alkalized and heated, if it is not renewed by the Chyle: this Heat damages the following Tranſpiration, as appears by what we have already ſaid. *9thly*, At Night we tranſpire twice as much as by Day; the moderate Heat of the Bed and the Nerves of the external Parts, which are relaxed, while thoſe of the Heart act very briſkly, the Ceſſation of violent Exerciſes, and the Interchange of Cold and Heat which we ſuffer by Day, are the Cauſe of this *Phænomenon.* 10*thly*, During the five Hours after Supper, we tranſpire but one Pound; but the three following Hours we tranſpire three: this can be explain'd by what we have already ſaid in the firſt Article: but if we ſweat whilſt we ſleep, Tranſpiration will be diminiſhed by the Reaſon already given; if we ſtir about in the Bed the ſame will happen, by reaſon of the Cold which is felt by reſting our Joints in divers Places: interrupted Sleep produces the ſame Effect, becauſe the Blood then cauſing great Agitations, vehemently propels the nervous Juice, ſtops the Extremities of the Arteries, and produces Sweat. The Wearineſs we feel in a Morning, as alſo ſwoln Eyes, are a Sign that we have not ſufficiently tranſpired; for the Fulneſs cauſing Stoppages retards the Courſe of the Fluids, upon which depends the Action of the Body; beſides this, it ſwells the Parts, which eaſily yield, as the Eyes. 11*thly*, Too much Reſt hinders Tranſpiration, becauſe it weakens the Fibres, as we ſhall ſee hereafter; the Fluids are propel'd with leſs Force when there is no Agitation in the Body, for it ſends into the Nerves the Juice which is the Cauſe of their Tenſion. 12*thly*, Exerciſe contributes much to Tranſpiration and ſenſible Evacuations; for there is then preſſed into the Inteſtines a Humour which renders the Matter flowing: beſides, the Motion of the Muſcles of the *Abdomen* puſhes the *Fæces* downwards; but the time wherein Exerciſe augments Tranſpiration moſt, is five or ſix Hours after Meal; then the Matters are diſpoſed to exhale, becauſe they have been attenuated by Circulation. We ſhall know the proper Exerciſes by the more or leſs violent Motions which it cauſes in the Body. 13*thly*, The moderate Uſe of Venery contributes to Tranſpiration, by reaſon that the Exerciſe is pleaſant; and by reaſon of Contraries, the immoderate Uſe of theſe Pleaſures ſtops the Exhalation of the Fluids; but the Want of theſe Pleaſures produces the ſame Effect as the immoderate Uſe, the ſeminal Matter which is gathered heats and dries the Fibres; beſides, the Privation of theſe Pleaſures cauſes Melancholy: All this can diminiſh Tranſpiration. 14*thly*, We won't enlarge upon the Paſſions, they increaſe or diminiſh Tranſpiration according to the greater or leſs Motion they cauſe in the Body; ſo that we ſhan't be ſurpriz'd to find *Sanctorius* mention, that moderate Paſſions cauſe plentiful Tranſpiration.

If the Ducts of Tranſpiration are cloſed by any Cauſe, thoſe of the Sweat, which are larger, receive a greater Quantity of Fluid that iſſues out by Drops: Here is the Explication of ſome *Phænomena* of this ſenſible Tranſpiration.

When the Chyle is not changed into Blood, as in conſumptive Perſons, when the Veſſels are dilated in Heats, when the Blood is propel'd with Violence, as in violent Exerciſes, Sweat muſt trickle down, becauſe the *Plethora* cloſes the Canals of Tranſpiration.

But if the Blood is propel'd with too much Violence, the Arteries compreſs likewiſe the ſudorific Canals; which is the Reaſon that Cordials often ſuppreſs the Sweat.

In Agonies and Faintings the Blood ſtops; and this is the Reaſon that the aqueous Part is preſſed out: the ſecretory Veſſels, which are then relaxed, reſiſt not the Force which propels the Blood.

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In

cauſed the Diſſolution has more Affinity with volatile Alkaly than with Mercury; ſo that it muſt leave the mercurial Parts to be join'd to that Salt. 2*dly*, The acid that is found join'd with the volatile Alkaly is ſeparated from it, to give place to the nitrous Acid, and is mixed with the Mercury precipitated by its Weight, which is not borne up as before; but this Precipitation ought not to make us conclude that the Salt of Sweat is Alkaly, it is *Sal Salſum*, if it has not been preſerved a long while.

The Subſtance of the Sweat muſt be thicker than that of Tranſpiration, becauſe it is filtrated thro' larger Canals: As theſe Canals take their riſe from ſanguinary Veſſels, the Blood may paſs there if they are dilated to a certain Point; thus we may be ſubject to Sweatings of Blood. It is this Communication of the Blood-Veſſels with thoſe of the Sweat that cauſes it to have the ſame Smell and Colour of things which we have eat. It is reported in the *Ephemerides* of *Germany*, that Rhubarb coloured the Sweat of one *Mentzel*. *Bartholine* gives us an Account of a Scholar, in whom *Spaniſh* red Wine produced the ſame Effect. Beer can paſs thro' the ſecretory Canals of the Skin. The Smell of Garlick and Sourneſs of the Juice of Lemons can be perceiv'd in the Sweat. *Salmouth* and *Bennet* bring Examples of it. Children at the Breaſt exhale a milky Acid by Tranſpiration. In certain Bodies the Sweat has an agreeable Smell, in others a very diſagreeable one. *Edmund de Meara* aſſerts, that a Man (whom he knew) when he had drank much Wine ſmelt like a Corpſe. *Pechlin* gives us an Account concerning one of his Friends, who always ſmelt of certain Parts that ſhall be nameleſs, and which changed to the Smell of Muſk when he was ſick. The Smell of the Sweat is the Occaſion of People's immediately perceiving a Cat.

There are Writers who aſſert, that Parents and Children, who knew not one another, took a ſurprizing Pleaſure in looking on each other. If this be true, we may attribute it, according to ſome Authors, to the *Effluvia* which ariſe from the Skin.

REMARK V. *Of the Hairs.*

THERE are a great many Enquiries to be made upon the Hairs: Men have Beards, and Women have none: They grow in certain Parts, and not in others: They are black in the Armpits, Groins, *Anus*, *Linea alba*, *Hippogaſtrum*, Thigh, Legs, Arms; and in the other Parts of the Body they are not the ſame: in Infants, in Adults, and in old Men they vary very much.

We mention'd, that the Hairs were fixd to the Skin exteriourly; but we find them implanted in the Fat, nay even ſometimes deeply rooted. They ariſe from thoſe ſmall oval Corpuſcles, whereof the famous Monſieur *Chirac* gave us a Deſcription. Theſe oval Follicles are compoſed, according to his Opinion, of two Membranes, the one external, the other internal; the external is tendinous, an infinite Number of ſmall Filaments, which ariſe in *Faſciculæ*, form its Texture: it is lined inwardly with a glandular Membrane, which (according to the Opinion of that above-mention'd learned Gentleman) appears to have ſome relation with the cortical Subſtance of the Brain. In that Capſule we perceive the Roots of the Hairs, which is bath'd with a Fluid that is continually filtrated there. Before the Body of the Hairs ſprouts, at the Root there is a medullary Subſtance, which without doubt furniſhes its Nouriſhment. That Body of the Hair is compoſed of ſmall Roots which meet together; it is ſurrounded with a great number of blackiſh Lines, that are extended from the Root to the Extremity; likely theſe Lines are ſanguinary Veſſels deſtin'd for the Nouriſhment of the Hairs.

Mr. *Ruyſch* mentions the Hairs in a Letter, and in his *Theſaurus Anatomicus*. He is of opinion, that they are nothing but a continuation of nervous *Papillæ:* He takes notice of them as of vaſcular Parts. *Leeuwenhoek* is of the ſame Opinion. I could not exactly diſtinguiſh Mr. *Chirac*'s Opinion concerning the Structure of the *Capſulæ*.

Bidloo aſſerted, that the Hairs ſend forth Branches; he has given us their Figure: but with the greateſt Exactitude of the Microſcope we can't diſcover this; we can't but obſerve a pretty ſmooth and diaphanous Body. Very likely the Hairs this Anatomiſt examin'd had ſomewhat particular in them.

As the Hairs are Expanſions of nervous *Papillæ*, as they are vaſcular, as their Roots are bath'd with ſome Fluid, it will follow, 1*ſt*, That they muſt grow: 2*dly*, That we muſt feel ſome Pain when they are plucked off; the Nerves, from which they are ſeparated, then ſuffer a Solution of Continuity.

The blackiſh Lines above-mention'd being ſanguinary Veſſels, it follows, 1*ſt*, That in thoſe whoſe Veſſels are large enough to receive a large Quantity of Blood, the Hairs will be black. 2*dly*, That in thoſe where they will not be enough dilated, nothing but an Oil or Lymph will enter; and conſequently the Hairs will be fair. In the Northern Countries they are contracted by the Cold, and conſequently they only receive a Lymph or Oil; and therefore in thoſe Climates they will be fair: But in the Southern Countries, as they are rarefied, the Blood enters, and conſequently they will be black. 3*dly*, That they will be black in Adults rather than in Infants; for, beſide the Augmentation of the Veſſels of the Hairs in Adults, the Fibres which convey thither the Nouriſhment, augment in Strength;

and therefore the Blood is carried to the Root with greater Force. *4thly*, That the Blood may flow thro' the Hairs, as it happens in a Diſeaſe call'd *Plica*, which is peculiar to the *Polanders*. *5thly*, That in old People the Hairs ought to become white, for every thing withers in old Age; and conſequently the Blood cannot enter every where as before.

Women have no Beards, altho' Men have at the Age of eighteen. *1ſt*, The Faces of Men are dry, we generally obſerve this in thoſe who have ſtrong Beards; but the Faces of Women are better preſerv'd. *2dly*, Men tranſpire much, Women but little; conſequently there remains a thick and black Blood in Men, whilſt Fluid in the other Sex. *3dly*, The Fibres are ſtronger in Men than Women; they can therefore propel the Blood with greater Strength: and theſe are the Differences between Men and Women. Can theſe Differences be the Cauſe of all theſe *Phænomena?* Some would immediately ſay, (according to that) that Women could not have long Hairs in other Places: I own we can't exactly anſwer this Difficulty: But could we not anſwer, That the Blood is carried in great Quantities to the Parts of Generation, and that the Armpit is a very hot Place; and that thus the Blood occaſions the Growth of the Hairs in thoſe Parts in Women?

The Hairs in certain Subjects are curl'd, in others not. Some Authors have wrote, but without Foundation, that the Occaſion of it was the Drineſs of the Hairs. There are Hairs that curl, which are moiſter than others that do not curl; we find theſe Examples daily: It is true that the Hairs of the Privities are always curl'd; that without doubt can be occaſion'd by nothing but the Heat. But we muſt obſerve they are rather frizzled than curl'd; and that can be ſurely attributed to the Heat.

Hair frizzles near a Fire; the Moiſtneſs exhaling the ſolid Parts approach one another, and take different Situations, according to their different Diſpoſitions; for there is certainly another Cauſe to which the Curls are to be attributed: no doubt it proceeds from nothing but the Figure the Hairs take in the Pores. If they iſſue out of winding Pores, they take the ſame Figure; and when they are expoſed to the Air, their Parts contract in the ſame Order as they receiv'd in their Paſſage.

Before we leave this Subject, we muſt obſerve how the Hairs become forked, and whence they take their Colour. 1*ſt*, Mr. *Chirac* obſerv'd, that the Bodies of Hairs were nothing but a Bundle of ſmall Threads that may be ſeparated. 2*dly*, The Hairs can become white, if we exhale the blackiſh Matter out of their Veſſels; and it is done by the Dew: for their black Colour is a true Tincture.

The Uſe of the Hairs is as unknown to us as that we have juſt now been ſpeaking of. Some Authors have aſſerted, that the Groins were cover'd with Hair, that the Parts ſhould not rub againſt one another in Coition. But all this is trifling; and thoſe who are of opinion, that the Hairs ſerv'd as Props to the ſecretory Ducts, are not leſs ridiculous.

There is no doubt but that Providence furniſhed Beaſts with it to defend them from the Injuries of the Seaſons, and gave it Men for the ſame Purpoſe; but as to thoſe in the reſt of the Parts, we can't account for their Uſe.

REMARK VI. *Of the Fat.*

ACcording to the Obſervations of *Malpighi*, the arterial Veſſels being divided, are ſpread in the Cells of the *Membrana adipoſa*, which ſerves them as a Baſis; and in theſe Cellules the oily Subſtance of the Blood is ſecreted: the more thoſe Cellules are fill'd, the more the Surface of the Skin that covers the Body is ſmooth and poliſhed. In order to carry that Oil into the Cellules there is no need of Veſſels, but in thoſe Places there muſt neceſſarily be arterial Pores thro' which the Fat may tranſude: in the ſame manner there is a Neceſſity of Pores to carry back that Oil, and place it in the Veins. The Marrow is a ſort of Fat which is ſeparated in the Cavity of the Bones: *Bergerus* aſſerts, that the external Membrane of the Arteries by its Expanſion forms an infinite Number of Cellules, thro' which the Oil that forms the Marrow is filtrated; but this is uncertain: What we are certain of is, that there is a Membrane which enters the Network, and forms there Cellules reſembling Bunches of Grapes. This Membrane ſticks to the internal *Perioſteum*, and receives the Oil of the Arteries. *Clopton Havers* was of opinion, that they were Glands which filtrated that Oil; but theſe are not neceſſary, and we have no Proof of their Exiſtence. Some Authors believ'd, that the Marrow ſuffer'd ſome Changes according to the Increaſe and Decreaſe of the Moon: This is but a vulgar Opinion, which wants Proof; it diminiſhes only according to the animal Motions.

There is filtrated in the Articulation of the Bones a ſort of oily Subſtance call'd *Synovia*; it iſſues out of certain Organs call'd *Synovial Glands*: it is in order to facilitate the Motions, that Nature placed theſe ſecretory Organs in the Articulations. The chalky Matter that is depoſited in the Jointures when we are attacked with the Gout, proceed from thoſe Glands.

If we mix Spirits of Nitre with Oil of Olives, that Compound reſembles Marrow, and melts on the Fire: If we leave thoſe two Subſtances in Digeſtion for ſome Days, the Fluid Part is exhaled, and there will remain a more ſolid Maſs.

The Marrow may take its Riſe from the ſam Origin; but we are not to ſuppoſe that there is i Human Blood nitrous Spirits like thoſe uſed i this Operation.

REMARK VII. *Of Muſcular Motion.*

THE Action of the Muſcles is determin'd b the Direction of their Fibres; ſo that we ca eaſily ſee the Effects the Muſcles of the *Abdome* can produce. In order to be perfectly acquainte with them, we muſt examine thoroughly th moveable Parts upon which they act; their Actio either compound or ſimple, their Obliquity, th fixed Point in their Motions: I don't enter upc Particulars, becauſe it would be too tedious. now ſhall treat of the Structure of the Muſcles general, and the Cauſe of their Action.

All the Muſcles are compos'd of a tendino and fleſhy Belly; they may be divided into ſma Muſcles, which are alſo tendinous and fleſhy: the ſmall Muſcles can be reduced into ſtill ſmalle where the ſame Structure is to be obſerv'd. No withſtanding theſe Diviſions, there may be ma others yet ſmaller; and ſo *ad infinitum.* The muſcular *Faſciculæ* are compoſed of Fibres, whi are neither Arteries, Veins, nor lymphatic Veſſe The Nerves in entring the Muſcles caſt off t Membrane which inveſted them; they are ram fied afterwards throughout all the Subſtance of t Muſcle; there is not a Point where they are n to be found: theſe Nerves at laſt vaniſh. Can not ſay, that theſe nervous Extremities are e panded, and form thoſe muſcular Fibres? We in other Parts of the Body, that thoſe ſmall Ner grow much larger, and are expanded in the Fo of a Membrane, as we may obſerve in a great ma

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Places: May not theſe muſcular Fibres be an Expanſion of Nerves? Could not this Production form a long and continued Cavity or Veſicles? But however, there are Fibres that form muſcular *Faſciculi*; theſe *Faſciculi* are wrap'd up in a particular Membrane that ſeparates them from others: this Membrane is cellular, fill'd with an Oil that proceeds from the Arteries, as appears by the Injections of Mercury. Notwithſtanding this Membrane is only an Expanſion of that which covers the Muſcle, it penetrates into the Subſtance of the Muſcle, and is expanded thro' the Interſtices of the muſcular *Faſciculi* which it covers; thus it ties the one to the other, and ſeparates them at the ſame time.

There are Arteries that enter the Muſcles; their Ramifications are ſo numerous at firſt Sight, that we might believe they compoſe the whole Muſcle: they are ſpread thro' the muſcular *Faſciculi* in the Membrane that ſeparates them, and perhaps even upon the Surface of each Fibre: They there form, according to the Opinion of *Ruyſch*, reticular *Plexus's*; they end in oily Filtres. And *Ruyſch* is alſo of Opinion, that they terminate into lymphatic Veſſels: perhaps they degenerate into hollow Fibres that inoſculate with thoſe of the Nerves. It is certain that there is not a Branch of Arteries which doth not anſwer to a Branch of Veins, and which at laſt unite with other Ramifications, to form a large Trunk. There are alſo Lymphatics that ariſe from the Muſcles.

A Tendon may be divided into as many Fibres as a Muſcle itſelf; for it is nothing elſe than muſcular Fibres more compact: the Blood-Veſſels are not viſible in it; but *Ruyſch* has diſcover'd in them an infinite Number by his Injections. The Union of the Fibres forms the Tendon which is call'd *Aponeuroſis*, if it is extended as a Membrane. The ſmall *Faſciculi* are tendinous, as we have already ſaid. According to the various Arrangement of theſe *Faſciculi*, the Muſcle takes divers Figures. Placed one over-againſt the other, they form a rectangled Parallelogram or obtuſe Angle. Many of theſe Parallelograms diverſly ſituated, will form Muſcles of various Figures, as the *Trapeſius*, and the *Deltoide* Muſcle, *&c.*

The Muſcles are the Inſtruments by which we move our Bodies; they are as the Reins, in order to turn the Solids of one Side and the other. Theſe Motions are perform'd by the Contraction of the Muſcles. When the Muſcle contracts, the two Points to which the Muſcle is fixed muſt neceſſarily approach one another.

Nothing is more difficult than the finding the Cauſe or Mechaniſm by which the Muſcles are ſhorten'd. This is cauſed by the Dilatation or Contraction: the Dilatation appears at firſt Sight; but there is good Reaſon to believe, that the Body of the Muſcle takes up leſs Space during the Contraction; and conſequently it is ſhorten'd. 1*ſt*, The Heart acts by being contracted. 2*dly*, The Muſcles grow pale when contracted, conſequently contain leſs Blood. 3*dly*, The Fibres ſeem to ſhrink in the Contraction of the Muſcles. 4*thly*, If a Man dips his Arm into a Veſſel full of Water, that Water, according to *Gliſſon*, deſcends when the Muſcles of the Arm are in Contraction. 5*thly*, The Muſcles when in Contraction are more rough, which cannot happen by the Dilatation. 6*thly*, When we cut the *Apex* of a Heart alive, and introduce our Finger, it preſſes the Finger by its Contraction, and is contracted on all Sides. From theſe Facts it follows, that there is a real Conſtriction in the Contraction of the Muſcles.

In order to explain the Contraction of the Muſcles, they have had recourſe to a kind of a *Materia Subtilis*,

tilis, which flows in the Nerves, and returns, according to the Opinion of ſome Authors, from the Extremities to the Head, in order to convey thither the Impreſſion of Objects: It is true, that the Fluid which runs in the Nerves ſeems to be the only Cauſe of the Contraction of the Muſcles; but we cannot prove in the animal Body the Exiſtence of ſuch a Fluid which comes from the Brain, and returns into it, the propelling Force in the Nerves is always ſuperior to the Motions that Objects cauſe in the Nerves: beſides, when a Muſcle ſlackens ſuddenly, thoſe Spirits in reflowing would make Impreſſions in the Brain. That Reflux therefore does not exiſt, it is contrary to the Laws of Circulation which is obſerv'd in animal Bodies, and nothing but the Facility of explaining a *Phænomenon* that has induced ſome Authors to embrace it. Neither can the Blood ſtopped in the Veſſels cauſe the Contraction, for it is preſſed out of the Muſcles. For another Proof, we may only obſerve that the Veſſels which are in the muſcular Subſtance are very ſmall, and on account of their Minuteneſs may look upon them as cylindrical; but cylindric Tubes contract not when they are ſwell'd; the Reaſon is evident: Therefore it would be neceſſary for the middle of a Tube to be dilated much more than the Extremities. This is impoſſible, becauſe the Tube being cylindrical, the Extremity is dilated by the ſame Quantity of Matter as the middle. I could produce ſeveral other Reaſons from the Mechaniſm, but this ſimple Reaſon ſufficeth; there remains but one *Phænomenon*, which is as follows.

If there were Veſicles between the nervous Fibres, and that thoſe Veſicles receiv'd nothing of the Blood, or any other Fluid that ariſes from the Blood, but during the Contraction, it would follow, that thoſe Veſicles inflated would raiſe the nervous Fibres, and divide them from one another: the Tendons therefore would neceſſarily approach one another. But, 1*ſt*, Theſe Veſicles are a mere Suppoſition; it is true that this alone is not ſufficient to reject it: but at leaſt we have a Right to demand, that this Hypotheſis may anſwer the *Phænomena* that are to be explain'd. 2*dly*, By this Suppoſition we muſt ſay, that the Veſſels permit no more the Blood to take its uſual Courſe; for if the Blood could flow there as before, it would not be forced to enter the Veſicles. They may perhaps advance, that the Blood is propel'd in the Muſcle with greater Force: But where is the Cauſe of this more violent Force? Beſides, if that ſhould be the Caſe, would the Muſcle grow pale? Therefore the Paſſage of the Blood muſt be ſtopped in the Veſſels: But what is the Reaſon of it? Some will ſay at firſt that it is in the Contraction of the Nerves, which are then agitated by the moving Power. Let us ſee whether this anſwers to the *Phænomena* of muſcular Contraction. Let us ſuppoſe that in the Relaxation of the Muſcle, the Motion of the Blood which preſſes the Sides of the Arteries is equal to 4, that Blood is ſtopped, and as it always comes there afreſh, the Preſſure augments; ſuppoſe this Preſſure amounts to 10. this Exceſs of Preſſure cauſes the Blood to enter into the Veſicles we were ſpeaking of: But hence it evidently follows, that the Arteries become more turgid; conſequently the Muſcle ought not to be pale nor occupy leſs Space; which is contrary to Experience. I ſhall perhaps be anſwer'd, that the Blood in ſwelling the Veſicles contracts the Veſſels; But again there would be a *Momentum* where the Muſcle ought to be more inflated and more red. We can by this ſee the Foundation upon which *Baglivi*'s Opinion is founded, which differs but little from that which we now were ſpeaking of. The Explication of muſcular Motion given by Mr. *Deidier* is not more ſolid. This Author ſuppoſes in a Theſis, that the nervous Fibres contracting in a Muſcle, the Blood would flow there in a leſs Quantity than its Antagoniſt, which carries it off that Way. Theſe are his Expreſſions: *The nervous Filaments are gathered as long as the Muſcle is in Contraction: By this Contraction the Blood flows eaſier in the Antagoniſt; hence it is that that Antagoniſt exceeds in Quantity the Muſcle already contracted by the Diſpoſition of its Structure.* There is no need of refuting this Opinion, there is not one Reaſon to ſupport it.

From all theſe Reaſons it evidently follows, that it is not the Blood that ſwells the Veſicles, nor the Veſſels in the Contraction of the Muſcles. Beſides, let us reflect upon the Heart of an Eel, which beats a long time after it has been ſeparated from its Veſſels: The ſame Principle by which it beats, is the Principle of the Contraction of the Muſcles; for we cannot ſay that the Action of the Blood occaſions the Pulſation of the Heart. One of the greateſt Men of our Age has given an Explanation concerning muſcular Motion which is unworthy of ſo great a Genius. When the Will, ſays he, ſends the nervous Juice into the Muſcles, the Parts of that Juice by their ſubtle Points are fixed to the Particles of the Blood and divides them, and then the Parts of Air encloſed in that Blood form an Ebullition, and are dilated at once. That Air is not a thick but a very ſubtile one, which eaſily evaporates, as ſoon as by a ſudden Impetuoſity it has rarefied the Blood. There are two ſtrong Points in the nervous Juice, they break the Cellules where a great many thick Parts of Air are encloſed; hence it is that Veſicles ſometimes appear on the Surface of the Muſcles. It is by the Formation of ſuch Veſicles that (according to the Opinion of this Author) the Dropſy call'd *Tympanites* is produced. Probably he never obſerv'd that this Tumour proceeded only from the Air which bloats the Inteſtines; it is (according to the ſame Author) a vulgar Error to attribute the Palſy to an Obſtruction of the nervous Juice: It is more probable (he thinks) to ſuppoſe it a Diminution of the *pungitive* Quality in the nervous Juice. Strange Suppoſitions! A Lover of Hypotheſes need but affirm that there is an igneous Matter in the Nerves, and that when it penetrates the Muſcle, it is enflamed and rarefied with the Fat of the Muſcle. Is not this Suppoſition as well grounded as that of this Author's? This Opinion has appear'd in divers Manners; *Willis*, I think, was the firſt Inventor of it: he ſaid there was an Exploſion in a Matter which run thro' the Nerves of the Head to the Extremities. A famous Profeſſor was of the ſame Mind; he found a Similitude of all what paſt in the Contraction of the Muſcles to the Action of Gunpowder: the animal Spirits mixed with the Blood are rarefied at once, (as that Author believes:) he call'd this Rarefaction *exploſive Copulation.* What Imaginations! What falſe Ideas! Can we find in our Fluids any Principle that reſembles Gunpowder?

The Opinion of Dr. *Keil* is nothing but the *exploſive Copulation* expreſſed in other Terms. This Author, who had nothing in his Head but the Attraction or unknown Cauſe of Sir *Iſaac Newton*, ſuppoſes that the Parts of the nervous Juice have an extraordinary Attraction, and as ſoon as they are mixed with the Blood, attract the Particles that compoſe it: theſe Parts more ſtrongly attracted occupy leſs Space; by that means the Air contained in the Blood is ſuddenly dilated, and ſwells the Muſcles; this Inflation, in approaching the Tendons, cauſes the Contraction. Ridiculous

Opinion! 1*ſt*, This Author explains the Contraction of the Muſcles by the moſt unknown *Phænomenon*, *viz.* Attraction. 2*dly*, He ſuppoſes that the Air which is rarefied ſwells the Muſcle; but the Rarefaction of the Air ſhould anſwer, as he thinks, to the Condenſation of the Fluids whoſe Parts approach one another: thus the Muſcle will not change its Situation. In the reſt Dr. *Keil* finely demonſtrates in what manner the Veſicles are ſwell'd, but without paying Juſtice to *Bernouilli*, from whom he copied.

Theſe are not the only Opinions occaſioned by muſcular Contraction; there are Philoſophers who were of Opinion, that the muſcular Fibres were ſpiral, whoſe Circumvolutions were join'd by Fibres that after Contraction ſhorten'd the ſpiral Line. Others, to reconcile themſelves to this Opinion, imagin'd ſanguinary Veſſels that were in the Cavity of the ſpiral, and which in being ſwell'd augmented the Diameter of the Circumvolutions. We may judge of theſe Opinions by what has been ſaid.

Bergerus advanced, that the membranous tranſverſal Fibres being extended, wrinkle the fleſhy Fibres: And we are no leſs in the dark by this Expedient than by the precedent ones. They make *Steno* ſay, that the Angles of Fibres which were acute, became Rectangles: But by what Mechaniſm is this done? and how can we ſuppoſe that Spaces fill'd with Fluids that preſs equally on all Sides can have acute Angles? Every ſimple Cavity fill'd with a Fluid which is propel'd by Force, muſt neceſſarily be round.

As we meet with infinite Difficulties in muſcular Motion, we muſt examine the *Phænomena* we meet with, before we pretend to explain them. Here are Facts we learn from daily Experience. 1*ſt*, All the *Faſciculi* of the Muſcles are in a violent Tenſion; for when they are cut tranſverſly, the thus cut Parts ſhrink towards their Origin, diſcharge the Juice which they contain, and are contracted in a leſs Compaſs: Hence it follows that every Muſcle muſt have its Antagoniſt, otherwiſe the Muſcles would always incline to one Side only. 2*dly*, If the Fibres of Muſcles are longitudinally divided in an Animal, and are ty'd in the middle, the two Sides are ſwell'd up, or rather compacted in that Contraction: but if two Ligatures are made, and are diſtant from one another, the Part of the Fibre which is between the Ligatures won't ſwell at all; thoſe that are towards the Tendons, or on t'other Side the Ligatures, can contract. 3*dly*, If the Brain is compreſſed or wounded at a certain Point, muſcular Motion ceaſes, there only remains a ſpontaneous Action in the Heart and Muſcles of Reſpiration; but if the *Cerebellum* be compreſſed, wounded or cut, Life, Reſpiration, and Motion of the Heart ceaſe in an inſtant; there only remains a periſtaltic or vermicular Motion in the Inteſtines. 4*thly*, If a Trunk of a Nerve which ends in a Muſcle by its Ramifications is compreſſed or cut, Action will ceaſe in that Muſcle: If we in the ſame manner compreſs or cut the ſpinal Marrow, all the Parts whoſe Nerves take their Riſe from that Part of the Marrow which is below the Wound, will be depriv'd of Motion: The ſame happens if we cut or tie an Artery which ſupplies that Muſcle with Blood. 5*thly*, If we tie an Artery that brings the Blood to a Muſcle, and inject luke-warm Water into the Muſcle under the Ligature thro' that Artery, Motion returns. 6*thly*, If we inject luke-warm Water into the Muſcle of a Body juſt dead, Contraction is reviv'd. 7*thly*, If we tie the Nerve of the Diaphragm, and preſs downwards between the Fingers the Part which is under the Ligature, the Diaphragm is again contracted.

tracted. *8thly*, The Muſcles ſubſervient to voluntary Motion receive Nerves from the Brain; and thoſe that are ſerviceable to ſpontaneous Motion, from the *Cerebellum*. *9thly*, The Tendon of a Muſcle is not inflated during Contraction, at leaſt it doth not appear ſo. 10*thly*, If an external Force bends the Arm, as for Example, the *Muſculus Flexor*; notwithſtanding the Effort of the Will, it is put in the ſame State as when the Will makes it act, but the Contraction is not ſo ſtrong. 11*thly*, If a Muſcle is in Action whilſt its Antagoniſt is unactive, it overcomes it; if both of them act with Violence, the Part to which they are fixed is ſtiff. 12*thly*, The Contraction and Relaxation of a Muſcle are perform'd at the ſame inſtant; and hence it follows, that the ſame Cauſe can be preſented to a Muſcle, and diſappear at the ſame time, without leaving the leaſt Mark. 13*thly*, Whilſt the Will acts not upon the Muſcles, all the Parts are in a perfect *Equilibrium*; but if we cut them tranſverſly, as for example, the *Extenſor* of the Arm, the *Flexor* would immediately overcome it. 14*thly*, The Force which contracts the Muſcle is equally diſtributed every where in the inſtant that the Will acts.

Theſe are the *Phænomena* found in the Contraction of Muſcles; let us ſee whether we cannot find a Cauſe which produces them. We have already ſaid, that the fleſhy Part of a Muſcle decreaſed; this Diminution may happen, either by the Inflation of the nervous Fibres that compreſs the Blood-Veſſels, or by their Contraction, which ſtraitens the ſame Veſſels. As for Contraction, the elaſtic Virtue of thoſe Fibres is the Cauſe of it; but it is evident that it is not the Spring that cauſes this Contraction. 1*ſt*, In Subjects juſt dead, the elaſtic Force is almoſt the ſame as in living Subjects; yet there is no Contraction in Muſcles whoſe Antagoniſts are cut. 2*dly*, When an external Force bends the Arm, then the *Flexor* is ſhorten'd by the elaſtic Force; but it has not the ſame Hardneſs then, as when the Will acts: therefore the Force which contracts the Muſcle muſt be different from that which ariſes from Elaſticity. There is another Cauſe which appears at firſt to be able to occaſion the Approach of the Fibres, *viz.* the Privation of the Fluid which dilates them: We ſee that the Solids of a Body depriv'd of their Moiſture, approach one another by the Force of the ambient Air; but there is no room for that in the Contraction of the Muſcles; all is relaxed in a Human Body, as ſoon as the Parts are depriv'd of their Fluids, to which they all owe their Tenſion. There remains therefore the Inflation of the nervous Fibres. Let us ſee how it can happen, and produce the *Phænomena* met with in the Contraction of the Muſcles.

Let us ſuppoſe a Bladder which, 1*ſt*, is not inflated with Air; 2*dly*, which has a Weight hanging at its Bottom; 3*dly*, a little Tube at its Neck: if we blow thro' the ſmall Tube, 1. the Bladder muſt be inflated; 2. by this Inflation the Bottom approaches the Neck; 3. the Bottom approaching the Neck, it is neceſſary that the Weight hanging at the Bottom be raiſed: all this is confirm'd by Experience. This Experiment preſents two things which muſt be explain'd: 1*ſt*, We muſt enquire why the Bladder in ſwelling takes a circular Form? 2*dly*, What is the Power that raiſes the Weight hung at the Bottom of the Bladder? The Bladder being inflated, muſt form a circular Line; 1*ſt*, Becauſe the Fluids preſs, according to the perpendicular Lines, the Surfaces upon which they act. 2*dly*, Becauſe the Preſſure of the Air is equal on all Sides. Two celebrated Mathematicians demonſtrated, that the Bladder ſhould be of a circular Figure. But theſe general Reaſons are ſufficient.

The Power by which the Weight is raiſed has been determin'd by Mathematicians. I won't fill this Work with Calculations; therefore I'll only lay down a general Principle, as follows: When we raiſe a Weight with a Lever, the Force of the Power applied to the Lever is always greater when the Lever is longeſt; the Reaſon of which is, that when the Weight which muſt be raiſed has but a ſmall Space to paſs, while the Power has a much greater: there is therefore found a greater Motion in the Power. The Reaſon why we can raiſe a Weight fixed to the Bottom of the Bladder is the ſame.

Let there be a Tube of a ſmall Diameter and a Bladder of a long one; whilſt the Air will paſs a long Space in that little Tube, the Bladder will ſwell but very ſlow; conſequently the Bottom and the Weight will riſe towards the Neck but very ſlowly: But, as we have already proved, that in order to augment a Force, we muſt diſpoſe it in ſuch a manner that it may paſs a great Space, whilſt the Body which it raiſes advances but a little Space; conſequently the narrower the Tube of the Bladder is, the greater will be the Force of the Air when we blow thro' that Tube.

Hence it follows, 1*ſt*, That if we hang a Weight at two Bladders, placed one at the Side of the other, the Force will be double. If we hang it at three, that Force will be triple, *&c.* 2*dly*, If we place two Bladders, one above and t'other below, and that they have ſome Communication with one another, the Weight which is fixed to the Bottom of the inferior will be raiſed twice as high: conſequently if a Cord were nothing but a Series of Bladders, the Elevation of a Weight fixed to the End would be proportionable to the Number of the Bladders.

If in the Muſcles were to be found a Series of Bladders, placed as we now mention'd, and that there were a Fluid there ſent; according to the Order of the Will we ſhould have the Cauſe of the Contraction of the Muſcles.

We have above eſtabliſhed the Exiſtence of thoſe Bladders by probable Reaſons. *Leeuwenhoek* thought to have obſerv'd them by a Microſcope, but he retracted from it. *Borelli* has obſerv'd, that if we preſent to the Fire the fibrous Parts of Muſcles, they ſwell'd, and form'd a ſpongy Subſtance. This proves ſomething of the Exiſtence of the Veſicles, as alſo *Cowper*'s mercurial Injections.

As for the Fluid that is ſent in thoſe Veſicles, it is nothing elſe but a Liquid that flows in the Nerves. 1*ſt*, *Leeuwenhoek* has obſerv'd of late, that the Nerves are Tubes. 2*dly*, If a Fluid did not run thro' the nervous Tubes, it would be impoſſible for the Nerves to act; their Tenſion would not be ſufficient for it. I'll prove it demonſtratively. When we pinch or cut a Nerve in ſome Part, it is there convulſed: we may extend as much as we will the Strings of an Inſtrument, nay even to break them, they'll never yield any extraordinary Motions: It is the ſame with the Nerves. Beſides, Reaſon and Experience tell us, that if we ſplit the String of an Inſtrument, by preſſing it upon any thing, no Vibration enſues; there is no Reaſon there ſhould: but the Nerves, when they are divided, will ſoon occaſion Convulſions. We muſt therefore allow, that there is an abſolute Neceſſity for a Fluid to flow in the Nerves. This is prov'd alſo by the Experiment we mention'd of the diaphragmatic Nerve ty'd, which moves the Diaphragm as ſoon as we preſs out the Fluid which is contained under the Ligature. Beſides, if in the Nerves Tenſion alone were the Principle of their Action, how can we explain their State of Reſt in which they are found to be when tied? We cannot ſay that Motion ceaſes there, by the ſame Reaſon that the String of a Violin doth not vibrate when it is tied; the Nerve above the Ligature has Life in it, altho' the String of the Violin, being tied, acts not at all. We can therefore eſtabliſh, that when a Muſcle is contracted, the Soul ſends thither the nervous Juice that inflates the Veſicles.

But we may enquire, 1*ſt*, Whether thoſe Veſicles muſt be of the ſame Length with the Muſcles. 2*dly*, How there can be found ſo large a Quantity of nervous Juice to fill thoſe Bladders. 3*dly*, How thoſe Bladders can diminiſh the Quantity of the Blood in the Muſcle. 4*thly*, What becomes of the nervous Juice carried in the Veſicles. 5*thly*, How the Veſicles can be inflated in an inſtant.

The Veſicles can't be of the ſame Length as the Muſcle. 1*ſt*, They would take up an extraordinary Space when inflated. 2*dly*, They would contract the Muſcles but very ſlowly, becauſe the Contraction would depend upon the Velocity with which the Bottom of the Bladder approaches the Neck; but the greater the Bladder is, the ſlower the Bottom approaches the Neck. 3*dly*, There would be a Neceſſity for an extraordinary Quantity of nervous Juice.

It appears at firſt, that there is requir'd a great Quantity of nervous Juice to inflate the Veſicles of a Muſcle; but ſimilar Bodies are in a triple *Ratio* of their Diameter; therefore there is a Neceſſity that the more the Veſicles diminiſh, the leſs Fluid there is to fill them in Proportion. Let there be two Bladders, the Diameter of one be triple, in regard to the Diameter of the other; 27 times more Fluid would be neceſſary to inflate the great than the ſmall Bladder, and the great one would take up a Space 27 times greater. Thus 3 ſmall Bladders will have 9 times leſs Fluid than the great one, to raiſe a Body to the ſame Height: That a leſs Force may inflate theſe Bladders, we need but leſſen their Bulk, and increaſe their Number: Thoſe Bladders can be multiplied, and ſo ſmall, that the Force ſufficient to diſtend them will be found to be infinitely ſmall. In order that the Bladder which we mentioned ſhould raiſe a Body a Foot high, 100 Bladders, each of which ſhall be the 100th Part of this, will produce the ſame Effect; but they muſt have 10000 times leſs Matter. All this is demonſtrated.

But (it is objected) how comes it to paſs that the Inflation of theſe Veſicles leſſen the Quantity of Blood in the Muſcle? This will neceſſarily happen, if the Veſſels are compreſſed. But it is evident that the Veſſels which are in the Muſcles ſurround the nervous Fibres; theſe Fibres cannot therefore be inflated without compreſſing the Veſſels, and conſequently without preſſing out the Blood and making the Muſcle pale: hence it happens that the Blood is gathered in the Arteries at the Entrance of the Muſcle, and by its Force it can at laſt overcome the ſwelling of the nervous Veſicles; which is the Reaſon, in ſome meaſure, of the Difficulty of keeping a Muſcle a long time in Contraction.

When the Muſcle is ſlacken'd, what becomes at laſt of the nervous Juice which is collected in the Veſicles? 1*ſt*, It doth not return, as we have already ſaid. 2*dly*, It muſt then evaporate or enter into the Blood by the way, of which we have already ſpoken in the Structure of the Muſcle; all this may happen: and this is the Reaſon of Laſſitude, which almoſt conſiſts entirely in the Evacuation of the nervous Fluid; the Nerves being no longer diſtended by that Fluid, can neither ſuſtain nor move their Parts.

There remains the laſt Queſtion, *viz.* How the Veſicles can be fill'd in an inſtant. 1*ſt*, As the

Quantity that inflates them is infinitely ſmall, there is a Neceſſity of but very little time to convey it. 2*dly*, The Veſicles are very ſmall; they want therefore but little time to be inflated, provided that they have each a Tube: for if there were but one that had a Tube, and ſent the nervous Juice to the reſt that had ſome Communication with it, there would have been a long time requir'd. 3*dly*, The Bladders of each Nerve may be very large in compariſon of the nervous Tubes, altho' they be not ſenſible; beſides, the reſpective Largeneſs of thoſe Tubes is made amends for by their Length: a Ball is puſhed ſtronger out of a long Tube than out of a ſhort one.

Here are ſome Propoſitions that follow from all we have juſt now ſaid. 1*ſt*, The Fluid that inflates the Veſicles comes from the Head; thus a Nerve tied or compreſſed, can give no Motion to a Muſcle. 2*dly*, The Veſicles cannot contract the Muſcles without the Help of the Blood; for the Fibres that are gathered in a Tendon are divided in a Muſcle; the ſanguinary Veſſels that are between them remove the one from the other, and by this means cauſe a Tenſion: But when the ſanguinary Veſſels are not inflated, they won't be ſo diſtant from one another, nor ſo much diſtended. After the ſame manner, when a Cord is ſlack it is not diſtended by Water, as if it were leſs ſlack. 3*dly*, Altho' the nervous Fluid acts with a great deal of Force upon the Muſcle, it doth not hurt the nervous Canals thro' which it paſſes. The hydraulic Machine ſhews us, that with a Straw by which we blow up a Bladder, we raiſe conſiderable Weights without breaking the Straw; the Reaſon of which is not difficult to find out. 4*thly*, A Muſcle can be inflated by too violent a Motion. 5*thly*, The Blood ought to be rarefied by the Motion of the Muſcles. 6*thly*, Muſcular Motion ought to preſs out the Oil which is contained in the cellular Subſtance; thus Animals muſt grow lean when they uſe too much Exerciſe. *7thly*, In old Age, when the Muſcles become a ſort of Tendons, Motion muſt be weak, becauſe the Blood flows there in a leſſer Quantity, and ſo doth the nervous Fluid alſo. *8thly*, Spontaneous Motions muſt be cauſed by the nervous Juice which continually flows from the *Cerebellum* into the Muſcles, without the Order of the Will.

The Force of the Muſcle depends, *1ſt*, Upon the Direction of the muſcular Fibres; for the Muſcles whoſe Fibres are oblique or tranſverſe, have more Force than thoſe whoſe Fibres are longitudinal. *2dly*, The Force of the Muſcles muſt not be meaſured by their Contraction; the Muſcles whoſe Fibres are oblique have more Force, yet they contract leſs than thoſe whoſe Fibres are longitudinal; notwithſtanding theſe Muſcles, whoſe Fibres are longitudinal, are contracted one third. *3dly*, It follows from all theſe Propoſitions, that the Weight cannot be a Rule to determine the Strength of the Muſcles. *4thly*, The Force of the Muſcles depends upon the Lever to which they are fixed, upon the Pullies, their Obliquity, perpendicular Situation, Crookedneſs, and Direction of thoſe that help them, and their proper Length; for a long Muſcle contracts more than a ſhort one, ſince the Muſcles become one third ſhorter in their Contraction, if their Fibres are longitudinal: hence it follows, that that muſt be a long Muſcle, when the Parts mov'd are to run over a great Arch, as the Part of the Arm between the Elbow and the Wriſt upon the *Humerus*; ſo that a Muſcle cannot move it, becauſe it contracts but a third Part, or the third Part of a ſmall Muſcle is leſs than the third Part of a great one.

REMARK VIII. *Of the* Peritonæum.

THERE is nothing more difficult than to give an exact Idea of the *Peritonæum*; no Author has clearly deſcribed its Windings and Turnings; it is even impoſſible to explain it without a Demonſtration: We muſt obſerve, *1ſt*, That the *Peritonæum* is compoſed of two *Laminæ*. *2dly*, That thoſe *Laminæ* are united by the cellular Subſtance of *Ruyſch*. *3dly*, That when we preſs thoſe *Laminæ* between the Fingers, there iſſues out a Fluid: It is between theſe Membranes that many Writers have placed Glands in the ſame manner as in the *Pleura* and *Pericardium*; but thoſe Glands have not been obſerv'd but in Bodies that died of ſome lingring Diſeaſe. In my Opinion, thoſe Glands that have been obſerv'd are nothing but unnatural Tubercles, it is ſome viſcous Matter ſtopped in the ſmall Arteries of that Membrane which form'd them. If we reflect upon that, we ſhould not ſo much have multiplied the Glands. The great Mr. *Cheſelden* aſſerts, that he found in a Dropſical Woman the *Peritonæum* three Fingers thick, and the Glands (ſays that learned Anatomiſt) appear'd very clearly in it. Is it not probable thoſe Glands were unnatural? We have no more Reaſon to take thoſe Bodies for Glands than Tumours, or other Excreſcencies that are viſible in other Parts.

In order to have an Idea of the *Peritonæum*, we muſt imagine that the internal *Lamina* of the *Peritonæum* penetrates the *Abdomen*, and there forms inflated Bladders; it is in theſe Bladders that the *Viſcera* are lodged. Towards the Perforations of the Muſcles, the external Coat is elongated, to form a Bag for the ſpermatic Veſſels; the internal Coat that is over the Place where thoſe Veſſels penetrate, ſhuts the opening in Men, but not in Dogs. In a *Hernia* the internal *Lamina* falls, and forms as it were a ſecond *Capſula*, in which the Inteſtines or *Omentum* deſcend. The ſame thing happens in Ruptures, which are form'd at the Paſſage of the crural Veſſels. *Herniæ* proceed from the Relaxation of the *Peritonæum*; *Swammerdam*'s Obſervations have put it out of doubt.

REMARK IX. *Of the* Epiploon.

THE *Epiploon* is compoſed of two *Laminæ*, join'd by the cellular Subſtance of *Ruyſch*; it is a Continuation of the *Peritonæum:* It is in this manner that it is form'd; over the Meſentery, the internal Coat of the *Peritonæum* is extended; this Extenſion is a Duplicature of that internal Coat of the *Peritonæum*, and is call'd *Meſacolon*, becauſe it covers the inteſtine *Colon:* after the *Meſacolon* has covered the *Colon*, it is extended, and embraces the Ventricle; when it has embraced the Ventricle, it is extended again, and ſurrounds the Liver. The Spaces of that Membrane which are between the *Colon* and *Stomach*, between the *Ventricle* and *Liver*, is call'd *Epiploon*. Hence we may ſee that we ought not to ſearch for its particular Uſe, it being nothing elſe but an Expanſion of Membranes by which Nature joins the *Colon*, *Stomach*, and the *Liver*. In ſome People this Membrane is vaſtly extended, and can deſcend by theſe Means in the *Scrotum*; in others it is extended but little, and it can't extend but it muſt form a Bag.

By this Deſcription we ſee all the Adheſions of the *Omentum*; it is not join'd to the Kidneys, Spleen, and *Pancreas*, but as much as it is a Production of the Membrane that covers thoſe *Viſcera*. As for its Structure, it has been perfectly deſcrib'd by *Malpighi*; but we muſt add, that *Ruyſch*'s cellular Subſtance is between the two *Laminæ*. In that Subſtance it is the ſanguinary Veſſels creep. The Arteries form reticular *Plexus* round the ſmall Bags of Fat; the Veins that anſwer them in like manner form them. *Malpighi* looks upon the *Ductus Adipoſi* as particular Veſſels; but in his Poſthumous Works he left them undecided. *Morgagni* hints, that they are not neceſſary; he believes that the Secretion of the Fat can be perform'd by the Arteries that depoſited it in the Cells. He adds, that the Fat may return thro' the Veins, without any Neceſſity of the Veſſels *Malpighi* deſtin'd for that Uſe. The Veſſels are innumerable in the *Omentum*; when they are viſible, their Ramifications make the *Omentum* appear as a Net. In order that they may plainly appear, it is neceſſary that the Cellules of *Ruyſch*'s Membrane muſt not be too much fill'd with Fat.

In theſe Veſſels ſcattered in the *Omentum*, that are made of extremely thin Membranes, according to the Obſervation of *Ruyſch*, there is a vaſt Number of ſmall Holes upon their Surface. There is ſome appearance, that the Vapours which moiſten'd the Inteſtines and other *Viſcera*, are exhaled by the ſmall Holes of the Veſſels of the *Omentum*. It may be alſo that part of them may re-enter by the abſorbent Tubes. Finally, thoſe Exhalations are very ſubtile and volatile, their Origin and Smell ſhew it.

We can't obſerve ſecretory Veſſels in the *Omentum*; the Blood that continually flows thro' the left and right *Epiploic* Vein, carries the Lymph and Oil of the *Epiploon* to the Blood that enters the Liver: hence it follows, that the more an Animal moves, the more Oil muſt be preſſed out of the *Omentum*. Experience alſo teaches us, that the *Epiploon* is very lean in thoſe who uſe much Exerciſe. As the Veſſels are relaxed in Dropſical People, we ſee that the Veſicles of the *Epiploon* deſtin'd to receive the Fat, muſt be fill'd with a *Serum*. The ſame thing muſt happen to thoſe who have been weaken'd and grown lean by Maladies. Laſtly, we ſee why the *Viſcera* that adhere to the *Omentum* have no Fat. The large Quantity that is contain'd in the *Omentum* doth not permit any to be depoſited in the neighbouring Parts.

It ſeems at firſt Sight, that the Blood that re-enters the Liver is a Blood depriv'd of Spirit; that which returns from the Stomach has depoſited its Lymph, and has paſſed thro' many Strainers; but in advancing by the ſhort Veſſels, thro' the right gaſtropiploic Vein, thro' the greater Gaſtric by the left Gaſtropiploic, thro' the Pyloric, it is mixed with the Blood that returns from the *Omentum*; perhaps it is ſtill charged with a thin Fluid that the abſorbent Veſſels of the Stomach have ſqueez'd from the Aliments: The ſmall Branches of the Pancreas, the internal Hemorrhoide, brings a Blood which is perhaps more acrimonious. Laſtly, all the Blood that came to the Inteſtines by the ſuperior and inferior meſenteric Arteries, returns by the meſenteric Veins. In its Way it has depoſited in the Inteſtines its Lymph, but it perhaps carries a Part of the Chyle with it, and joins with the Blood of the *Omentum*. Hence it appears that the Blood in the *Vena Porta* muſt be fluid, and abounding with Lymph: It is propel'd from this Reſervoir by the Heart, the Spring of the Arteries and Veins, and by Reſpiration. Thus we may ſee the Diſeaſes that an obſtructed Liver can produce.

REMARK X. *Of the Stomach.*

THE firſt thing to be obſerv'd in the Stomach is the external Coat, which is nothing but a Continuation of the *Peritonæum*, and is extended from one Orifice to the other; altho' this Membrane is pretty thin, its Fibres are very large and ſtrong towards the two Orifices: theſe Fibres alſo become ſhorter or longer according to the different Situation of the Stomach. The ſecond Coat is compoſed of carnous Fibres, that form the two Superficies; the external ſurround the Stomach as Hoops, they cut the Fibres of the Tunic which we now have deſcribed, at right Angles: the internal are ramified obliquely upon the Stomach. In the internal Part of this Coat we muſt obſerve a Superficies of Fibres that are extended longitudinally from the *Pylorus* to the right Orifice. The firſt Order of Fibres, by means of their Contraction, draws the Stomach narrower; the ſecond brings its Length into a ſhorter Dimenſion: the *Faſciculi* of Fibres that are at the ſmall Curvature bring the two Orifices near one another.

Between the Coat which comes from the *Peritonæum* and the muſcular Coat, appears that of *Ruyſch*, which is a cellular Subſtance that penetrates into the muſcular Fibres; in the Cellules of that Subſtance is filtrated an oily Fluid. Next to the muſcular Coat comes the nervous, which is compoſed of Fibres of different ſorts: There are ſome Authors who have placed after this Tunic the vaſcular. There is but a Net of Veſſels that are ſpread in the Filaments that ariſe from the nervous Coat: that Network deſerves not the Name of a *Coat*.

After the nervous Tunic, appears the *Villoſa*; it is covered with Filaments that reach into the Cavity of the Stomach; when we examine it with a Microſcope, it appears like Honey-combs: We are to obſerve upon its convex Surface, 1*ſt*, Glands that are fixed to the Network of the Veſſels; 2*dly*, Arteries that come from the Cyliac and Epigaſtric; 3*dly*, Veins and Nerves that form a wonderful Lacing, and Tubes that open into the Cavity of the Stomach.

In the concave Part of the *Villoſa*, we are to remark, 1*ſt*, A Fluid that iſſues out from the ſmall Canals that ſpring from the Arteries; this Fluid is clear, ſubtile, and ſharp in Animals that have ſuffer'd Hunger a long while; it is not at other times either acid or alkaline. 2*dly*, The mucilaginous Juice that is filtrated in glandular Bodies is gathered in Follicles, and iſſues out thro' Openings that form a ſort of Nipples: This appears in the Writings of *Ruyſch* and *Morgagni.* 3*dly*, The Wrinkles that appear in divers Places, and that ſerve to ſtop the Aliments and Juices that are filtrated from the Nipples. As for the Veſſels, thoſe that are of the ſmall Curvature are call'd the Coronary, thoſe that ſurround the great one are nominated Gaſtric. The Nerves take almoſt the ſame Courſe with the Veſſels.

Thus much for the Structure of a Human Stomach: It is not the ſame in all Animals; in Birds the Stomach is compoſed of two Pair of ſtrong Muſcles; it is lined within by two Membranes that are very hard, where there appear tranſverſal Wrinkles, but at the Entrance there is a ſecond Stomach: we ſee inwardly ſmall Hoops that appear a-croſs a muſcular Membrane; when we raiſe that Coat where thoſe Hoops appear, there are found a vaſt Number of round oblong Glands, ſituated upon the muſcular Membrane. Theſe Glands, divided according to their Length, appear hollow; they open into the Cavity form'd by this ſecond Ventricle, and there diſcharge a white Fluid; in Birds of Prey there are many globular Subſtances. *Malpighi* aſſerts, that in an Eagle, not only the upper Part of the Stomach, but even the *Oeſophagus* abounds with oval Glands; and that ſmall Tubes appear there, that riſe from the nervous Coat, and ſecrete a Fluid.

After having ſeen the Structure of the Stomach, we'll examine its Uſe; it is in that Cavity Digeſtion is perform'd. Let us now examine whether it is done by Trituration or Fermentation. Here are ſome Propoſitions, whence we may conclude for one or t'other of theſe Opinions. 1*ſt*, There is nothing but the Chyle that paſſes into the lacteal Veins, for the Excrements contain but the fibrous Parts; beſides, there is need but for little time to form the Chyle, and the ſolid Fibres demand a great while to be diſſolv'd. It may nevertheleſs be, that there are ſome of the ſmall Fibres that paſs into the Chyle: this perhaps is the Reaſon of that fibrous or (if I may ſo call it) wooly Part that we ſee in the Blood. 2*dly*, In order to prepare this Juice, there is no Menſtruum that diſſolves the Aliments by any acid or alkaline Principle. In the firſt place we find no ſuch acid Menſtruum in the Stomach; for Milk would always coagulate in Infants, and the fat Subſtance could not be diſſolv'd. Secondly, The Fluid of the Stomach is not alkaline; whatever Experiments we make, we can diſcover nothing that is of the alkaline Nature. Thirdly, There is a great Difference between the *Phænomena* of Fermentation and thoſe of Digeſtion: for, 1. Vegetables that ferment yield a hot Spirit, which the Chyle cannot. 2. Animal Subſtances that have paſſed thro' Fermentation, afford a *Sal Volatile*, which aſcends firſt: this happens not in the Diſtillation of the Chyle. 3*dly*, There muſt always be a certain Proportion between the *Caput Mortuum*, oily Matter, Acid, and Water, in order to produce a Fermentation: But is this found in all Aliments? 4*thly*, Chyle entirely reſembles Emulſions; we muſt therefore allow that it is form'd like them, *viz.* by the Expreſſion and Mixture of Oil and Water. 5*thly*, Fermentation will not always form a white Fluid; on the contrary,

trary, it forms tranſparent Liquids, which doth not agree with the Chyle. *6thly*, When we only uſe animal Subſtances, there is neither Acid nor Alkaly found in the Stomach; there only is in Animals a *Sal Salſum*: How then can Fermentation be perform'd? *7thly*, Meats are impregnated with Oil, but the Oils extinguiſh the Action of the Acid and Alkaly. *8thly*, Fermentation requires Reſt: How can this be found in the Stomach, where Digeſtion is better perform'd when ſeconded by Exerciſe? *9thly*, In Animals that cannot grind their Victuals by Maſtication, they have a Stomach in which there is a manifeſt Trituration; ſuch are the Birds: If we find ſome that have no ſuch Stomach, altho' they have no Teeth, it proceeds from their not uſing hard Meat. 10*thly*, It is difficult to conceive that Animals can live in any Fluid that ferments with Violence, as thoſe who defend that Opinion aſſert; yet Worms live in the Stomach. We cannot find an univerſal Diſſolvent in the Stomach. 1*ſt*, The Fluid that is there filtrated is of an aqueous Humour; all Experiments demonſtrate it. 2*dly*, It is not to be conceiv'd, Why an univerſal Menſtruum ſhould not diſſolve the Stomach, ſince it diſſolves a thouſand Subſtances that are of the ſame Nature as the Stomach itſelf? There have been many Reaſons produced to anſwer this: they talk of divers Experiments that ſeem to prove a very ſtrong Menſtruum: They have aſſerted, That Bones were diſſolved in the Stomach of Dogs: That there have been found the Bones of a Frog reduced to a ſort of Jelly in the Stomach of a Serpent: That there has been found the Stamp of ſome Money eraſed on that Side that touched the Stomach or Inteſtines: I don't ſpeak of thoſe who vainly imagin'd that the Oſtrich digeſted Iron. *Van Helmont* tells us, (with no more Foundation) that the Hens of his Yard digeſted Glaſs: It will appear that the firſt Experiments that I mentioned are almoſt as falſe as the laſt. We ſee that *Boerhaave* confirms, that Animals propel out of the Stomach the Fibres, the Tendons, Cartilages, Bones, almoſt without changing their Form, the Juice being only preſſed out. Beſides, we obſerve that Animals that digeſt perfectly well, void downwards Peaſe, Cherries, and Beans whole; theſe can very well eſcape the Motion of the Stomach, but how can it avoid the Action of ſuch a violent Diſſolvent?

Let us ask thoſe who affirm that Digeſtion is perform'd by Fermentation, to define exactly what they mean by Fermentation, and let them diſtinguiſh it, 1*ſt*, From the Heat; 2*dly*, From Ebullition; 3*dly*, From Concoction; 4*thly*, From the Effervеſcence that is produced by the Mixture of Water and certain Spirits, by Oils and certain acid Spirits. It is certain that thoſe Motions cannot be call'd Fermentation, that would be a Digreſſion from the Idea of Fermentations, and to change *mal a propos* the Names, without giving Ideas for them. According to what I have ſaid, they muſt limit Fermentation, as that of Wine. It would be difficult to find in the Stomach ſome Agents that have all the Marks of that Fermentation; for it excites Heat, it ſeparates the ſpirituous Bodies from the groſs ones, it forms a clear Fluid that affords an ardent Spirit. I am very well aſſured that we can find Diſtinctions to invalidate thoſe Proofs: But what can we fruſtrate in this manner?

We may further ask thoſe who affirm that Digeſtion is perform'd by Fermentation, 1*ſt*, Why is Digeſtion perform'd more difficultly, when the Ferment, I mean the *Saliva*, is in too great a Quantity? 2*dly*, Why the Ferment ſhould become, as they think, Acid or Alkaly, we are ſo embaraſſed when we are about finding a Remedy that facilitates Digeſtion in thoſe who have their Stomachs out of order? *3dly*, Why all the Acids being different, as the Acid of Sea-Salt, Nitre, and Vitriol, it is poſſible that there be an Acid in the Stomach that always produces the ſame Effect with all kind of Bodies? This is not the only Reaſon we can get out of thoſe who aſſert a Fermentation; they ought, *1ſt*, Not to affirm that the Ferments are vitiated, when a Man has a bad Digeſtion; it is as if they ſaid, that Opium wants a ſuporific Faculty, when it ſometimes produces no Sleep. *2dly*, Their Opinion ſhould be grounded on ſome Experiment; otherwiſe what Difference would there be between them and the Followers of *Sylvius de le Boe*, who attributed every thing to the Mixture of the Bile, pancreatic Juice, and the Fluid that is filtrated in the Stomach and Inteſtines?

Thoſe that admit of Trituration are better founded. *1ſt*, We ſee in the Stomach nothing but Muſcles that preſs the Aliments by continual and reiterated Impulſions. *2dly*, We ſee that the Motion of theſe Muſcles is ſufficient to expreſs the Juice of Subſtances with which we are nouriſhed; for the Stomach, Diaphragm, and the Muſcles of the *Abdomen*, have a great Force. *3dly*, Experience teaches us, that the Action of the Muſcles helps Digeſtion; Exerciſe is a Proof of it. *4thly*, We ſee that the Chyle perfectly reſembles Emulſions, and Trituration only ſuffices to form them. But the Defenders of Trituration went too far; they ſeem not to know the Action of any Fluid in the Stomach. *1ſt*, The Fluid filtrated in the Stomach is not neceſſary to macerate and ſoften the Aliments. *2dly*, The Air that is encloſed in the Aliments, doth it not act by its Spring? *3dly*, Doth not Heat aſſiſt in diſſolving the Subſtances that enter into the Stomach? *4thly*, The Fluids filtrated in the Pancreas, Liver, and *Duodenum*, are they not deſtin'd to moiſten the Aliments? Whatever we may ſay, we muſt entirely reject the Principles that act in Chymiſtry; no doubt there are as many true Amalgations form'd in the Stomach as in the Preparations of Chymiſtry. Are there no Diſſolutions made by Water that diſſolves the ſaline and mucilaginous Matters, by the Bile that is the Diſſolvent of the fat Subſtances, and by the Salts we uſe, or are contain'd in the Aliments? *5thly*, We muſt ſtill believe that this is ſufficient to explain all the *Phænomena* of Digeſtion. *1ſt*, Imagination is of great Influence there; we can't attribute the Dread we have of ſome Aliments to any thing elſe, and the Deſire of eating certain Things that have no Taſte, and are very diſagreeable. *2dly*, Attention, Chagrin, and Melancholy entirely diſorder the Stomach.

After having ſeen how inconſiſtent the Opinions are of thoſe who are either for Fermentation or Trituration, let us eſtabliſh the Cauſe of Digeſtion; let us, *1ſt*, Examine the Action of the Stomach, that Organ of Digeſtion. The Stomach no doubt has a Motion. *Wepfer* having given Poiſon to an Animal, and taking the Stomach out of the *Abdomen*, obſerv'd that it ſwell'd, that the ſuperior Orifice ſhut very cloſely, that there was a periſtaltic Motion from the ſuperior Orifice to the inferior, and that Motion preſſed out a Liquor thro' the *Pylorus*. *3dly*, Mr. *Boyle* try'd an Experiment which demonſtrates that the Stomach doth not act alone in the Action of Vomiting: Having given an Emetick to a Dog, he made an Inciſion whereby he enter'd his Finger upon the Stomach, which was not in a great Motion, but the Muſcles acted with an extraordinary Violence. *4thly*, As the Stomach is a Muſcle, it muſt act at leaſt by the

Compreſſion of its Contents. The circular Fibres contract the Bulk of the Stomach, the longitudinal ones diminiſh the Length, and thoſe that run from one Orifice to another, cauſe the two Orifices to approach one another: We ſee by this, that theſe Fibres laſt mentioned could not act without cloſing both Orifices; and the more the Stomach is fill'd, the cloſer the Orifices are ſhut; which is the Reaſon that if we eat moderately, the Stomach is emptied ſooner than when we eat to Exceſs.

Theſe are the Motions the Stomach can have; let us ſee how its Contents can be propel'd in the Inteſtines. We might think that the Aliments would return into the *Oeſophagus*, by the ſame Reaſon that they enter the Inteſtines. 1*ſt*, The ſuperior Orifice is cloſed up by its particular Contraction. 2*dly*, This Orifice is between the two *Columnæ* of the Diaphragm. 3*dly*, It makes a curved Line under thoſe *Columnæ*. 4*thly*, Thoſe *Columnæ*, as is evident from their Structure, cannot contract without cloſing the Orifice of the Stomach. 5*thly*, Thoſe *Columnæ* are contracted at every Inſpiration. 6*thly*, When thoſe *Columnæ* are contracted, the Diaphragm deſcends. 7*thly*, The Diaphragm in deſcending preſſes the Stomach and Inteſtines. 8*thly*, The Stomach and Inteſtines being preſſed, it is neceſſary that the Contents be mov'd towards the Place where reſiſtance is leſs; and it is leſs in the *Abdomen* than in the *Oeſophagus*: for we juſt now have ſeen, that in Inſpiration the *Oeſophagus* is cloſed by the *Columnæ* of the Diaphragm; ſo that the Aliments ought always to be propel'd towards the *Anus*. But let us now explain what can be the Cauſe of the Motion contrary to this, I mean Vomiting.

Some aſſerted, that Vomiting was cauſed, when the periſtaltic Motion of the Stomach was inverted:

but the Aſſertors of that Opinion had no Idea of the Laws of Motion. Is it not evident, that all lateral Preſſure upon a Tube propels the Fluid contain'd in that Tube towards the two Orifices? But the periſtaltic Motion is lateral; it muſt therefore propel the Contents of the Stomach towards the *Oeſophagus* as well as towards the *Duodenum*; it cannot conſequently produce Vomiting. Let us ſee in what manner it can be perform'd.

We have ſaid, that the Stomach had but a little Motion in Vomiting; but, 1*ſt*, It was ſtrongly preſſed by the Muſcles; ſo that the Convulſion of the muſcular Fibres is the chief Cauſe of Vomiting. We find in that Convulſion a Cauſe contrary to that which occaſions the Aliments deſcending towards the Inteſtines; for the Muſcles of the *Abdomen* being contracted, the Ventricle is compreſſed: If that Force is ſtronger than that of the *Columnæ*, the *Oeſophagus* will be forced, and the Aliments will return there; but it is eſpecially during Expiration that that Reflux will happen, becauſe then the *Columnæ* are not contracted. As for the Muſcles that compreſs the Stomach with Violence, it is neither the oblique nor the *Recti* that have the greateſt Power; it is the tranſverſal Muſcle that acts by its middle that is fixed to a tendinous Expanſion, and comes from the *Apophyſes Tranſverſales* of the lumbal *Vertebræ*, which is the Reaſon that a Cavity appears in the *Abdomen* when we vomit. The Reaſon why the oblique Muſcles and the *Recti* are not in great Motion, is, that the Preſſure made by a Line leſs crooked, is leſs than that which is cauſed by a Line more crooked; it is a Principle of Mechanics. Here you have the Reaſon of Vomiting; but there are ſome others: 1*ſt*, If the Stomach is too much fill'd, the tranſverſe Muſcle, which is then very much extended, will cauſe the Aliments to flow back by its Compreſſion:

preſſion: The Fibres of the Stomach irritated by that Fulneſs, can produce the ſame Effect, if they are convulſed. 2*dly*, If the Paſſage of the Aliments is ſtopped up ſomewhere in the Inteſtines, there will be a Matter gathered together, till the Space that is between the Obſtacle and the Stomach be fill'd up; then the Inteſtines, irritated by that Fulneſs and continual Preſſure of the Diaphragm, will cauſe Convulſions in the Muſcles of the *Abdomen*; and hence Vomiting. I have often tried this in Cats, whoſe Inteſtines I tied at a certain Diſtance from the Stomach; they did not begin to vomit, till the Matter fill'd the Space that was between the Stomach and the Ligature.

After having explained the Force of the Stomach and its Effects, let us ſee how high its Force can amount to. Some Philoſophers aſſerted, that the Force of the Muſcles was in a Ratio compoſed of the Breadth, Length, and Depth of the Muſcles, *i. e.* in a Ratio of their Weight; for the Weight of the Muſcle that bends the third Phalanx of the Thumb is 112 Grains; for by the 126th Propoſition of *Borelli*, the Power of that Muſcle is equal to 3720. Let us therefore take the Weight of the Muſcles of the *Abdomen* and Diaphragm, it will amount to 15126 Grains; and by the Rule of Three we ſhall find, that their Force will be equal to the Weight of 461219 Pounds. This is the Power of the Muſcles of the *Abdomen*; to which add the Force of the Stomach, which is equal to 12951 Pounds, becauſe it weighs 8 Ounces: What will be the Weight of all thoſe Muſcles together?

This Calculation is curious, and I wiſh it would agree with Truth; but it is unhappily falſe: 1*ſt*, We meaſure the Force of the Muſcles by their Weight. This Rule is not juſt; the Fibres of one Muſcle can be more relaxed than the Fibres of another of the ſame Weight, and then the Power won't be ſo great: Add to this, if in one of theſe Muſcles there are leſs Nerves than in the other, and that this ſmall Number of Nerves is outbalanced by the greater Veſſels, that contain more Blood than thoſe of the other; what Difference will there not be between the Power of thoſe two Muſcles? 2*dly*, We compare the Muſcles of the *Abdomen* with the Flexor of the third Phalanx of the Thumb; but the one acts by a Lever, and the others by compreſſing the Inteſtines laterally. 3*dly*, We compare again the Action of that Muſcle of the Thumb with the Stomach, which is but a Bag: Has the Contraction of the one ſo much Affinity with the Contraction of the other? Beſides, we ſpeak of the Stomach as if it were muſcular, whilſt, beſides the external *Laminæ* of the *Peritonæum*, it has a cellular Subſtance, the *Tunica Nervoſa* and *Villoſa*.

Aſtruc, Profeſſor of Phyſic at *Montpelier*, has depriv'd the Stomach of almoſt all its Power of Contraction: To prove this, he takes a Circle, and conſiders it as a Polygon compoſed of infinite ſmall Angles; he takes the verſed Sine of one of thoſe Angles; he at laſt makes it appear, that the Contraction of theſe Angles produces a Preſſure which is as the verſed Sine of one of thoſe Angles in regard of the total Diameter; that verſed Sine is infinitely ſmall in regard of the Diameter; ſo that the Preſſure will be infinitely ſmall. I am of opinion, that the learned Man of whom we ſpeak, would rather give us a captious Subtilty than a olid Proof. I won't detain my Reader in ſhewing n what the Demonſtration fails; it will ſuffice to ring here the Atteſtation of the famous Mathenatician *Gregory*, who has demonſtrated it to be othing but a Sophiſm; beſides, we plainly ſee hat it is falſe: if we tie but ſlackly the Body of a

Drum with a dry Cord, and afterwards throw upon it, we ſhall ſee with what Force the Drum will be compreſſed.

We cannot determine the Force of the Muſcles of the *Abdomen*; it is far from being ſo great as *Borelli* writes: If we put our Hand in the *Abdomen* of a Dog upon the Stomach, we ſhall find that the Preſſure is not ſo extraordinary. As for that of the Stomach, it is of no great Power; neither muſt we leſſen it as much as *Aſtruc*. The Preſſure of the Diaphragm, of the Muſcles of the *Abdomen* and of the Stomach, is conſiderable enough. We have juſt ſeen, 1*ſt*, That there is no Fermentation in the Stomach: 2*dly*, That there is ſomething wanting, in the Opinion of thoſe who maintain that there is but a ſimple Trituration. After having examin'd all theſe Opinions, we muſt eſtabliſh ours on Digeſtion: but before that, we muſt know what we underſtand when we enquire after the Cauſe of Digeſtion. When we aſk what Digeſtion is, we only enquire after the Cauſe that reduces our Aliments into Chyle: but before we examine that Cauſe, let us ſee what the Chyle is.

The Subſtance of the Chyle is but a Collection of many Bodies. 1*ſt*, The greateſt Part of it i pure Water. 2*dly*, In that Water there appears fibrous and glutinous Subſtance. 3*dly*, Amid thoſe aqueous and fibrous Parts there appears an infinite Number of Globules, and other ſmall irregular Bodies, that are nevertheleſs like a globular Figure.

By this Deſcription we ſee that the Chyle is Compoſition of oily and aqueous Parts. 1*ſt*, O mixed with Water forms Globules. 2*dly*, A Mixture of Water and Oil affords a white Liquor.

From thoſe Obſervations it follows, that th Chyle differs not from the Juice of the Aliments and thus it is but a ſimple Expreſſion of Alimen

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which compoſes our Nouriſhment. Here are again ſome Proofs that confirm it. 1*ſt*, The Colour of the Chyle is not always white in the Stomach; it varies a little, according to the Diverſity of Aliments. In the Stomach of Oxen it is found of a greeniſh Dye; in that of a Wolf black: in Hogs that live upon Wheat it is white. Thus far we ſee that the Juice of the Aliments is not much changed. 2*dly*, In the Inteſtines the Chyle grows whiter; the Reaſon of which is plain; the Oil being divided, is mixed better with the Water. 3*dly*, Laſtly the Chyle is perfectly white in the lacteal Veſſels; becauſe the Oil is well mixed with the aqueous Parts: but this Whiteneſs has not changed the Nature of the Juice of Aliments; the Chyle has the Smell and Taſte of it, and is ſubject to almoſt the ſame Changes.

Theſe Principles being laid down, it is not difficult to find out the Cauſe of Digeſtion. 1*ſt*, In the Aliments we uſe, there are gummy, mucilaginous, and ſaline Subſtances, that cannot be divided but by an aqueous Fluid: It is therefore neceſſary for an aqueous Humour to be continually in the Stomach. 2*dly*, As our Aliments are almoſt always mixed with a fattiſh Subſtance, the aqueous Humour would not be ſufficient to ſeparate them: there is a Neceſſity there for a Fluid impregnated with a ſaltiſh and ſulphureous Subſtance; which is the Reaſon that the *Saliva* is a ſort of lather'd Soap. 3*dly*, The Subſtances we make uſe of are too fat to be able to be diſſolved by the *Saliva*, moſt of which is aqueous; and this is the Reaſon that the Chyle is form'd but half in the Stomach, and that it requires a ſulphureous Diſſolvent: As ſoon therefore as the Aliments enter the Inteſtines, they meet with the Bile, which is an attenuated Oil join'd to a Salt. 4*thly*, The Fluids that divide our Aliments would not be ſufficient alone; it is neceſſary that the Motion of the Stomach aſſiſt them, and mix the Matters they have ſoften'd and divided. Theſe three Cauſes muſt always concur. If the two firſt are wanting, the Aliments will neither be divided nor ſoften'd; the Stomach will be compreſſed in vain; it will not be able to preſs out the Juice: but if Motion were wanting to the Stomach, the Matters would but divide and mix themſelves imperfectly.

In admitting the Cauſes we juſt now mention'd, we can explain all the *Phænomena.*

The Aliments will be divided in the Stomach; the Water will divide the mucilaginous, the Bile, and fat Subſtances; the Stomach, by its different Motions, will put an end to that Diviſion: I make uſe of the Word *Diviſion*, rather than that of *Diſſolution*; for the Aliments are not changed, their Parts are only ſeparated from one another.

The Juice of the Aliments is only changed into Chyle; the Fibres, Membranes, Tendons, Cartilages, Bones, Filaments of the hard Parts of Vegetables iſſue from the Stomach, without loſing almoſt any thing of their Form.

The tenacious Subſtances having preſſed out their Juice, it takes at laſt a white Colour; and in order thereto, it requires nothing but Oil and Water well mixed together: We ſhould not therefore be ſurpriz'd, that Matters of ſuch different Colours give at laſt a white Tinge; if their Juice is oily and aqueous, it will always whiten when it is well divided and mixed. All Matters proper for our Nouriſhment are oily and aqueous.

The Juice will be proper for our Nouriſhment: To prove which, it is not neceſſary to know how the Parts of Matter that nouriſh us are form'd; it is ſufficient only to know, that the Parts of the Juice of Animals and Vegetables, are ſuch as form, repair, entertain, and fill our Veſſels; for which Reaſon we need but ſeparate them, and laſtly to apply them to our Veſſels. The Stomach ſeparates them, and the Heart by its Impulſions applies them to the Veſſels that want repairing.

The Stomach ſhould not be divided or diſſolved as the Aliments. 1*ſt*, The Aliments we make uſe of are either ground in the Mouth, or are Fluids. 2*dly*. The ſame Parts are always ground in thoſe Aliments, inſtead of that in the Stomach; ſometimes one Place preſſes the Aliments, ſometimes another. 3*dly*, The Stomach reſiſts by the Number of its Membranes; a Blow that will bruiſe one Surface will not bruiſe many. 4*thly*, The Stomach always receives new Parts that repair what it loſt by its Action; but the ſame are not in the Aliments that are digeſted. 5*thly*, Without having recourſe to theſe three laſt Reaſons mention'd by *Pitcairn*, we can more clearly prove that the Stomach muſt not be hurt; its Motion is not violent, it is only gently preſſed upon in the ſame manner as the inteſtinal Canal: this Preſſure is capable to mix the Juice of the Aliments, and to expreſs them, but it cannot hurt the Sides of the Stomach. As for the *Saliva* and Byle, we muſt not ask the Reaſon why thoſe Fluids diſſolve not the Stomach, and at the ſame time diſſolve the Aliments. There is in the Stomach a vital Motion, that applies the Parts one to the other, and in this manner fruſtrates the Action of theſe Diſſolvents: beſides, this Objection has nothing in it that touches the Stomach in particular. I would feign know the Reaſon why Worms are not diſſolved in Water and Oil, ſince there are many Subſtances there diſſolved. The Explication of theſe *Phænomena* will anſwer that which is here objected.

In Winter Digeſtion is more eaſily perform'd than in Summer. 1*ſt*, The Stomach and Muſcles of the *Abdomen* are ſtronger in Winter, ſince there is exhaled leſs Subſtance. which nouriſhes and affords them Action; beſides, they are contracted by the cold in the ſame manner as all Bodies, nay even the hardeſt: ſo that the ſame Quantity of Matter will contract them in Winter more than in Summer, and conſequently they will act ſtronger. *2dly*, the Juice that muſt ſeparate the Aliments in the Stomach, flows not in ſo great a Quantity in Summer as Winter; for when Tranſpiration of the Skin abounds, the other Secretions are leſſened.

If the Juice of the Stomach is too abundant, viſcous, or acid, Digeſtion will not be perform'd. *1ſt*, The Sides of the Stomach will not be able to be applied to the Parts of the Aliments, becauſe they are removed by the Humour they contain; ſo that there will be nothing but that Humour which will be agitated. *2dly*, If the Humour that is in the Stomach is too viſcous, it cannot be inſinuated in the Parts of the Aliments; thus they will not be ſeparated. The large Quantity of Acids will be alſo an hindrance to the Separation of the fattiſh Subſtances; for the Acids will coagulate them, and hinder the Bile from dividing them eaſily. Exerciſe contributes much to Digeſtion; for the Muſcles of the *Abdomen* and Stomach are in a greater Agitation; thus they divide the Aliments better: But Exerciſe muſt be moderate; for if it is too violent, *1ſt*, The Aliments are precipitated into the Inteſtines, before that they have been well divided. *2dly*, As Tranſpiration is increaſed, there flows out Juice enough in the Stomach. *3dly*, As the Blood flows with greater Force into the Inteſtines, and their Nerves are agitated more, the Motions this cauſes in the inteſtinal Fibres hinder the Chyle from being inſinuated ſo well in the lacteal Veſſels.

If the Stomach is too full, Digeſtion cannot be perform'd. *1ſt*, The Fibres that go from one Orifice to another in the ſmall Curvature are very much extended, and ſhut the Entry and Exit of the Stomach. *2dly*, The Stomach can perform Trituration but upon the external Surface of the Subſtances it contains; ſo that it cannot mix them. *3dly*, There is not Juice enough filtrated in the Stomach for the Diviſion of all that is found contained in it.

During Digeſtion the Stomach muſt be inflated, the Air is rarefied by Heat; and when it happens that this Inflation is too great, the Air iſſues out with a ſort of Noiſe thorough the upper Orifice, and makes that which we call in *Latin Ructus*. If the Stomach is too much inflated by the Aliments, there ariſes Vomiting; becauſe the Muſcles of the *Abdomen* and Diaphragm being too much compreſſed, preſs the Stomach with Force: But if the Aliments muſt preſently make their Exit by Vomiting when they are in great Quantity, they make their Way into the Stomach but very ſlowly when it is not full; the Reaſon of which is, that the Muſcles of the *Abdomen* are then leſs extended.

The Opinion we have eſtabliſhed cannot be objected againſt, that the Diſſolution of hard Subſtances is perform'd in the Stomach of certain Animals: But, *1ſt*, This belongs not to Digeſtion; for Animals are not nouriſhed by hard Bodies which they ſeem to digeſt. *2dly*, It is falſe that the Oſtrich digeſts Iron; the Experiments mentioned thereupon are deſtroy'd by others: beſides, ſuppoſing we were to obſerve ſome Diminution in Iron ſwallowed by ſome Animals, would it be ſurprizing? Doth not Water alone diſſolve Iron and other Metals? *3dly*, The Bones Dogs eat diſſolve not; they are ground by the Teeth of thoſe Animals, and then the Fluid of the Bones is preſſed into their Stomach: Beſides, when they have been well ground by the Teeth, the Water and Byle can ſurely agitate and ſeparate their Parts. *4thly*, It is not ſurprizing that Frogs have been found reduced into Jelly in the Stomach of Serpents; but for the Bones, it is groundleſs, except that the Serpent has triturated them before. *5thly*, Some Authors report, that having made a certain Animal ſwallow down Money after having bent it, that convex Part which touched the Inteſtines was eraſed; which proves this was not done by a Diſſolvent, for that Diſſolvent would have acted on the concave Part as well as the convex. All we can ſay is, that it is the Water and Salt of the *Saliva* that has ſoften'd the convex Part of that Money, and that the rubbing eraſed the ſoften'd Part.

Before we finiſh this Remark, we muſt reflect a little upon the various Opinions that were advanced upon Digeſtion. Nature often offers us inexplicable *Phænomena*; but ſometimes when ſhe preſents us with nothing but very ſimple Effects, we enlarge the Object. On ſome Experiments, tho' not ſure, we immediately concluded, that there muſt be a violent Diſſolvent to the Stomach: On the other Side, Gentlemen (who rejected all Explanations founded upon Chymiſtry) admitted of nothing but Powers that ground the Aliments: but they went a little too far, boldly affirming, that the Stomach had Force enough to grind Iron, Bones, *&c.* Ridiculous Idea! inconſiſtent with common Senſe! Can a ſoft Subſtance grind Iron, which reſiſts the hardeſt Bodies? What Chimera's could not their Brain produce! This is not the only extravagant Thought on this Subject; People have judged the Chyle to be a particular Fluid, ſince it was deſtin'd to form a Machine ſo ſurprizing as our Bodies. They could not be perſuaded that groſs Matter contained ſo precious a

Fluid, or ſuch a Quinteſſence as ſome Authors term it; and therefore they did ſuppoſe that ſuch a Change was performed by a Fermentation in the Stomach. But Reaſon diſſipates this Phantom; it ſhews us that the Chyle is nothing but the Juice of Animals and Vegetables. In Plants this Juice was proper to form Tubes and fill them: it has the ſame Quality in our Body, where it produces the ſame Effects. The Animals have already been nouriſhed by thoſe Juices, their Parts are form'd from them; we have nothing to do but divide them; they will produce the ſame Subſtance in our Bodies as in other Animals, provided they are join'd by the ſame Force, *i. e.* by the Motion of the Heart.

REMARK XI. *Of the Action of the Inteſtines.*

THE Coat that is derived from the *Peritonæum* adheres to the muſcular Coat by many Filaments, and by the cellular Coat of *Ruyſch* that penetrates the muſcular Fibres: In the Cellules of this Membrane there is filtrated an Oil, which appears in fat People in the Form of Fat; it is not to be found in lean Subjects. The muſcular Fibres that follow, ſerve for the Motion of the Inteſtines. Theſe Fibres have been look'd upon as interrupted towards the Beginning of the Meſentery; but they are not by any means. When the Inteſtines are ſeparated from their Hold, the Surface of the muſcular Coat that touched the Meſentery is like the lateral Surface: We muſt not then look upon the Inteſtines as Muſcles, whoſe Tendons are the Meſentery. A certain modern Author looks upon the common Tegument as a Hold, or the Tendon of thoſe Fibres; but upon what Foundation? A Tegument which has no Support, and adheres to muſcular Fibres, but by very ſmall Filaments, can it ſerve as a Tendon? The annular Fibres in contracting diminiſh the Bigneſs of the Inteſtines, elevate the Valves, which then cloſe the Cavity better, becauſe they approach the Arch which is oppoſite to them in the Circumference of the Inteſtines. The longitudinal Fibres by their Contraction approach the circular ones, one to the other, and ſhorten the Inteſtines. By theſe Motions it appears, that the Contents of the Inteſtines are preſſed, divided, mixed, at the ſame time the Sides of the Inteſtines are diſcharged by divers Rubbings of a viſcous Matter which could adhere to their Sides. The inteſtinal Glands are alſo compreſſed by the Action of the muſcular Fibres, and preſs their Juice into the Inteſtines: But can the periſtaltic Motion, ſo much talked of, be occaſion'd by the Contraction of thoſe Fibres? It is the common Opinion, that after the circular Fibres are contracted, the longitudinal Fibres widen the Cavity of the Inteſtines by contracting in their Turn: They ſay that they are the Antagoniſts of the circular Fibres; they ought therefore to produce a quite contrary Effect, *viz.* that they ſhould widen the Inteſtines. 1*ſt*, The two Motions of Contraction which are obſerv'd in the circular and longitudinal Fibres, are not contrary to one another; the Contraction of the circular Fibres move the longitudinal towards the Center, and the Contraction of the longitudinal approach the circular Fibres, one to the other; how can theſe two Motions be contrary to one another? cannot the longitudinal Fibres approach the Center of the Inteſtines when they are mov'd by the Contraction of the circular Fibres? and cannot the circular Fibres approach one another? 2*dly*, What is the Cauſe that will produce thoſe alternative Motions? In thoſe muſcular Fibres, that which extends the

Nerves, doth it not flow equally in the two Planes of the Fibres? *3dly*, This Notion is very dubious, for other Reaſons. I have diſſected Dogs, without being able to obſerve it: I ſometimes made Ligatures; I have pinched the Inteſtines ſwell'd above thoſe Ligatures, but I never obſerv'd any alternative Motion. *4thly*, Could not the periſtaltic Motion that ſome Authors aſſert they have obſerv'd, proceed from a Contraction cauſed in ſome Part by a nearly ſtopped Reſpiration! or is there not rather ſomething that could contract the Inteſtines in ſome Place? The Inteſtines being yet warm, are contracted upon that Matter which inflates them; in contracting they draw the Remainder of the *Canalis Inteſtinalis*: this Canal being drawn, ought to be re-eſtabliſhed by its Spring in the ſame State as it was before. All this would cauſe ſome Motion in the Inteſtines. *5thly*, This Motion can't ſerve the Uſe aſſign'd to it; it was believ'd that it propel'd the *Fæces* downwards, while a lateral Motion that ſtraitens a Tube, equally propels of all Sides the Fluids that are contain'd in that Tube. But they will ſay, If the firſt Ring that ſucceeds the Stomach contracted before the others in ſuch a manner, that it enters the ſecond, and the ſecond the third; would not then ſucceſſively the Space be narrower above than below? and by this means would not the *Fæces* be obliged to deſcend? In order to eſtabliſh this, they muſt give a Reaſon why the ſuperior Rings ſhould contract rather than the inferior; there certainly is no Reaſon to be found: nor will any one ever explain how the firſt Ring will enter into the ſecond, ſince it has the ſame Circumference, and as much Force of Contraction: Beſides, when the Inteſtines will be larger at top than at bottom, (as it happens at the Extremity of the *Ilium*, which is leſs at its Entry into the *Cæcum* than any where elſe) their

Action will be contrary. I don't ſpeak of ſome Authors, who have obſerv'd that this Motion was made upwards; I have already ſaid enough to render it dubious. In the *Papillæ* of the nervous Membrane at the concave Part is a ſort of a Coat, which is nothing but a Contexture of ſanguinary Veſſels; the Arteries, 1*ſt*, Terminate into a Pulp, which has the Form of ſmall Pencils: 2*dly*, They join to the Glands of *Peyerus*. 3*dly*, They run thro' the ſecretory Canals that terminate in the Cavity of the Inteſtines. 4*thly*, The Veins that anſwer Arteries, either form with them a continued Canal, or come from the Glands of *Peyerus*, or open into the *Papillæ*. 5*thly*, It is in this Contexture the Glands of *Peyerus* are join'd, their Number and Bulk increaſe by degrees towards the Beginning of the great Inteſtines; there muſt be therefore in that Place more Heat and more Fluid filtrated. 6*thly*, Theſe Glands with their Points pierce the *Tunica Villoſa*. 7*thly*, It appears by this Structure, that when the Glands are preſſed by the Contraction of the muſcular Fibres, they muſt pour into the Inteſtines the Juice they contain.

If the following Coat were ſmooth and poliſhed, it appears that the Chyle and the Juice which is filtrated in the Glands could not remain in the inteſtinal Canal; this is the Reaſon that Nature has lined all the Cavity of the Inteſtines with the *Tunica Villoſa*: this *Villoſa* is three times longer than the *Nervoſa*, and eſpecially in the *Jejunum*. It is by this Length that it forms Wrinkles, which are more conſiderable towards the Meſentery. All theſe Wrinkles that detain the Chyle and the Excrements retain Remedies; ſo that they may have time to act and cloſe the Orifices of the Canals that diſcharge themſelves into the Inteſtines.

This is the Action of all the Parts of the inteſtinal Canal; but in order that it may continue long, Nature moiſtens it continually by a Matter that tranſpires from the *Omentum*, Meſentery, and other *Viſcera*. Without this continual Moiſture the Inteſtines would adhere to the *Peritonæum*, and would not preſerve their Flexibility. But for all this Liquor which moiſtens them continually, and ſeems as if it would relax them, they are very much contracted when the Animal is in a State of Health.

The firſt Action of the Inteſtines is the Intruſion of the Chyle into the Lacteals. 1*ſt*, It has been advanced, that the lacteal Veſſels do not open into the Inteſtines, and that they receive the Chyle by Pores: it is, ſay they, by Pores that the Parts of a Human Body receive Nouriſhment. But theſe Reaſons are not ſufficient; the Lymph is ſecreted thro' Tubes; the Chyle that is groſſer requires likewiſe Tubes for its Secretion. 2*dly*, It has been aſſerted, that the Chyle preſſed by the Contraction of the muſcular Fibres was propel'd in the Lacteals; but during the Contraction, all the lacteal Veſſels are cloſed, and the Chyle finds leſs Reſiſtance in flowing thro' the inteſtinal Canal: it muſt therefore follow that Courſe, and not enter into the lacteal Veſſels. 3*dly*, It is more likely that the Chyle enters into the Lacteals, by the ſame Reaſon that the Water riſes in Pumps and Syringes; the Matter which is in thoſe Lacteals riſes towards the Reſervoir, thoſe Veſſels being empty at their Beginning, the Air forces the Chyle there: this happens eſpecially when the Inteſtines are no more preſſed by the Motion of Reſpiration, then the Lacteals that were compreſſed by the Diaphragm are empty. The Chyle paſſes thro' the Lacteals, as we have already mention'd; but it is very dubious whether there is not a Part of it that enters into the meſeraic Veins, and ſo immediately into the Liver. 1*ſt*, Comparative Anatomy teaches us, that there is a Paſſage from the Inteſtines into the meſeraic Veins. 2*dly*, Oviparous Animals have no Lacteals. 3*dly*, The meſeraic Veins are very large and numerous. 4*thly*, Thoſe Veins perform the Function of Arteries. 5*thly*, There is a Quantity of Fluid collected in the Inteſtines that cannot be abſorbed by the Lacteals, and is not voided with the *Fæces*.

We have hitherto obſerved, that the Preparation of the Chyle is perform'd only by ſpringy Fibres, and that there is found there a ſaltiſh and oily Fluid: hence we may judge concerning the Acid of the Inteſtines and Stomach, which cannot be prov'd by Experience; concerning *Van Helmont*'s *Archeus*, which is that inviſible Spirit that animates the Bodies; concerning the Acidity of the *Succus Pancreaticus* that enters into an Effervеſcence with the Alkaly of the Bile, according to *Sylvius de le Boe*; concerning the Precipitation that depurates the Chyle, according to the ſame Author: In all this there is nothing founded on Experience.

After the Chyle has been prepared and preſſed out into the Lacteals, the Action of the Muſcles of the *Abdomen* always puſhes the groſſeſt Matter towards the *Rectum*: This muſt happen, becauſe the *Columnæ* of the Diaphragm cloſes the upper Orifice of the Stomach, that there is nothing which reſiſts in the Inteſtines. The Contraction of the inteſtinal Fibres, the Irritation cauſed by the Excrements in the nervous Membrane, gives a Motion to thoſe Excrements; and the Preſſure of the Muſcles determines them towards the great Inteſtines. By all theſe Motions the *Fæces* are divided and diluted.

Matter arriv'd from the right to the left Side of the *Duodenum*, from the left to the right about the Meſentery thro' the *Ilium*, enter into the *Cæcum*,

Cæcum, (by a long Opening, which is form'd by a flat Extremity of the *Ilion*, which enters into one of the Pleats of the *Cæcum:)* the muſcular Membranes, and others, join'd with the Membranes of the *Cæcum*, form a kind of Roll that ſurrounds the Orifice; it has been taken for a Valve: we might judge it to be ſo, by ſeeing dry Preparations; but at the two Extremities of that Opening, which is flat, there is a Ligament on each Side; theſe Ligaments or Bridles are made by the Pleats of the *Cæcum:* When this Inteſtine is inflated, theſe Pleats draw the two Extremities of the Opening, and ſhut it: Hence we may ſee whether it is poſſible that the Gliſters paſs into the *Ilion*; this may happen when the *Cæcum* is not entirely inflated.

The *Fæces* being arrived at the *Cæcum*, ſtop there; they are preſſed by their Weight, by the Action of the Fibres of the Inteſtine: by the Muſcles of the *Abdomen* the Lymph is preſſed out of it, and at laſt acquires a bad Scent, by the ſame Reaſon as Plants, when putrefy'd: This Compariſon is the more juſt, as that the Smell of Plants that have been putrefy'd, in being placed in Heaps have the exact Scent of *Fæces*.

There is an Appendix fixed to the *Cæcum* call'd *Vermiformis*, and which opens into this Inteſtine; it is the true *Cæcum* in Animals; it is ſpiral in Dogs, conic in Rabbits, lin'd with a *Lamina* forming a Spiral; in Hens it is double: in the *Fœtus* it is big enough in proportion to the Inteſtine, but in Adults it is very ſmall: Some ſay that there is a ſmall Valve at its Beginning, but it doth not appear in dried Preparations. As for the Glands, there are ſome at the Orifice; the Uſe of this is hitherto unknown: When they diſſected the Body of the Duke of *Berry*, they found ſmall Shot in the Cavity of the Appendix: it very likely proceeded from Game of which that Prince had eat.

The *Fæces* being triturated in the Inteſtine *Cæcum*, are thrown out of it by the Preſſure, and enter the *Colon*. This Inteſtine is very long, but by its Pleats it appears to be much ſhorter than it really is: it is fixed to three Ligaments that are extended throughout all its Length; theſe Ligaments, that are muſcular, are ſituated under the common Membrane and contract it; two of them terminate in the *Appendix Vermiformis*, and embrace it: this is perhaps the Reaſon why the Extremity of that Inteſtine cannot be widened as the reſt; if it were ſo, there would only remain the Explanation why the Inteſtine *Ilion* is not inſerted at the end of the *Cæcum*, but at ſome Fingers over it. To which we can anſwer, that Nature was willing there ſhould be a Place where the *Fæces* ſhould remain whilſt the *Fœtus* is in the *Uterus*; for which Reaſon there is no Opening at the Bottom of the Inteſtine. The *Fæces* being raiſed as high as the right Kidney under the Liver and Stomach, they follow the Circumvolutions of the *Colon* and enter the *Rectum*. This Inteſtine is but a Continuation of the *Colon*, the three Ligaments are ſpread round about, and render it yet ſtronger; its perpendicular Poſition, the Action of the acrimonious Matter that irritates its Fibres, the Preſſure of the Muſcles of the *Abdomen*, cauſe the Excrements to deſcend; which deſcended, ſtop at the Valves mention'd by *Morgagni:* then the Sphincters being preſſed, relax the *Relevatores* of the *Anus*, which are compoſed of convergent Fibres that ariſe from the Baſon, and ſurround the Extremity of that Inteſtine, dilate the *Anus*; then the Diaphragm and Muſcles of the *Abdomen* propel the *Fæces:* after they have made their Exit, the *Relevatores* elevate the *Anus*, and the Sphincters cloſe it again.

From all that we have ſaid, we may conclude, 1*ſt*, That the *Fæces* are compoſed of the groſſer Matter of the Aliments of the Bile, of the inteſtinal Lymph, and of the *Succus Pancreaticus.* 2*dly*, That theſe Matters are putrefied by the Action of the Bile that diſſolves them, and by the Heat that refines the volatile Salts: hence proceeds their Smell. 3*dly*, That Nature has placed ſeveral great Glands in the large Inteſtines, to give the *Fæces* a Fluidity that was taken from them by the lacteal Veins by Tranſpiration and Heat. 4*thly*, That Nature filtrates a mucilaginous Humour thro' theſe great Glands, that the *Fæces* may not rub the Inteſtines. 5*thly*, That there ſhould be ſome Fat round the *Rectum*, in order not to be hurt by the Bones. 6*thly*, That the Fibres being ſtrong, there muſt be a great deal more Heat in the Body, and conſequently there ſhould be a greater Tranſpiration; conſequently thoſe who are ſtrong will be coſtive. This ſame Evaporation of Fluids will ſtay the Blood in the *Rectum*, and will occaſion *Hæmorrhoides.* 7*thly*, The Connection of the *Rectum* and of the Bladder, is the Cauſe that we make Water with great Difficulty in Dyſenteries, that we are ſubject to the *Teneſma* when we are attacked with the Stone, or ſome other Inflammation of the Bladder.

Before we finiſh this, we muſt ſay ſomething of the *Volvulus* or Iliac Paſſion: In order to explain which, they have had recourſe to the periſtaltic Motion inverted; but by what we have already ſaid, we ſhall be able to judge whether it ariſes from this Cauſe. 1*ſt*, If we tie the Inteſtine of a Cat, and give it Victuals, it begins to vomit when the Matter fills the Space that is between the Ligature and the Stomach. 2*dly*, The further the Ligament is from the Stomach, the longer time it takes up before it vomits. 3*dly*, If we tie the Inteſtine in ſuch a manner that a Part of the Cavity is not cloſe, the Fluid iſſues out upwards and downwards. 4*thly*, Hence it appears that the *Volvulus* is cauſed by a total Convulſion of the Muſcles of the *Abdomen*, irritated by Pains that afflict the Inteſtines; but before that, there muſt have been a Contraction in certain Places in the inteſtinal Fibres: then the Part contracted enters that which is inflated by the Fluids and heated Air that come thither.

REMARK XII. *Of the Meſentery.*

THE Structure of the Meſentery has been very well deſcribed by ſeveral Anatomiſts; but it is difficult to form an exact Idea of it by their Deſcriptions. At the firſt *Vertebra* of the Loins, at the left Side, the internal Coat of the *Peritonæum* is ſeparated from the external, as a large Pleat that is very much extended: between the *Laminæ* that it forms, there is the cellular Subſtance of *Ruyſch*, which accompanies all the Duplicature of the *Peritonæum*; this Pleat deſcends obliquely upon the Spine towards the right Side; it terminates at the fourth *Vertebra* of the Loins. Towards the Extremity or pendant Borders of this Pleat, there are found Wrinkles or new Pleats, that tend towards the Center like the Pleats of a Ruffle. The Inteſtines are contain'd in the Circumference of the great Pleats or Meſentery, that ſuſtains them as a Scarf the Arm.

After the Termination of the Meſentery at the right Side, the *Ilion* enters one of the Pleats of the *Cæcum*: at that Place concur, 1*ſt*, the *Colon*; 2*dly*, the firſt ſtrait Curvature of the *Duodenum*; 3*dly*, the Kidney. The internal *Lamina* of the *Peritonæum* gives theſe three Parts a common Tegument; their cellular Subſtance is contiguous, ſince they are near one another; but that anterior

Lamina of the *Peritonæum* begins again to form a Pleat that aſcends in a Circle under the Liver, under the Stomach, and terminates at the left by contracting. Between theſe two *Laminæ* of that Pleat in the Place where they leave the poſterior *Lamina* of the *Peritonæum* is the *Duodenum*, which is placed tranſverſly: this Inteſtine is poſteriorly applied to the poſterior *Lamina* of the *Peritonæum*; it is cover'd ſuperiorly and inferiorly by the *Lamina* of the Pleat; theſe two *Laminæ* being united, after having cover'd the *Duodenum*, embrace the *Colon*, and it is that which we call *Meſocolon*. Towards the left Side the *Meſocolon* is ſtraiten'd, and applies the *Colon* to the poſterior *Lamina* of the *Peritonæum*; but it is lengthen'd at laſt in forming a new Pleat that contains the Crookedneſs, or *Roman* S, form'd by the *Colon*, as in a Scarf: This ſame Pleat is continued, and ſuſtains the *Rectum*; hence it comes that in this Part it is call'd *Meſorectum*.

From the Place the anterior *Lamina* is ſeparated from to form the Meſentery, iſſue out arterial Veſſels that are ſpread between theſe *Laminæ*, and environ the Inteſtines; there are Nerves that accompany theſe Veſſels.

By the Structure of the Meſentery, we ſee that there may happen ſeveral Diſeaſes; there may be a Dropſy between the two *Laminæ*; there may be a *Schirrus* form'd in the Glands that are there; the Veſſels that creep there may be enflam'd.

REMARK XIII. *Of the Veſſels of the Chyle.*

THE *Lacteæ primi Generis* ariſe from all the Circumference of the Inteſtines, like ſmall Syphons, and open obliquely into their Cavity, and at laſt inoſculate and ſlide into the Duplicature of the Meſentery. The Chyle that is inſinuated in them, is puſhed by the Chyle that follows by the Action of the Inteſtines, by the Preſſure of the Diaphragm and the Muſcles of the *Abdomen.* Were there not Valves in theſe ſmall Veſſels, the Chyle would be propel'd equally upwards and downwards: but as it is impoſſible to return, the external Preſſure obliges it to riſe towards the Loins; the ſemilunar Valves that open for the new Chyle, cloſe after that which is paſſed; the meſaraic Arteries that continually beat, forward its Motion, and puſh it into its Receptacle.

As the Orifices of the lacteal Veins are very ſmall, the moſt fluid and ſubtile Part can only be inſinuated. By the Structure of the Inteſtines and Smallneſs of the Orifices of the Lacteals, we ſee why acrimonious Subſtances that we uſe hurt us not; the Orifices of the lacteal Veins ſhrink by the pricking of the acrimonious Matter; the muſcular Fibres being pricked, cloſe the Orifices ſtill more: this is the Reaſon why the Structure of the Inteſtines, *Oeſophagus*, and Stomach, is different from that of the other *Viſcera.*

The Lacteals, whoſe Orifices are imperceptible to the naked Eye, appear pretty large when they are depriv'd of their muſcular Membrane; and when they are under the external Coat, they unite at laſt, and form acute Angles together. They ſeparate afterwards, in order to re-unite again. After they have been thus united and divided, they become larger. All theſe divers Growings ſerve to render the Chyle more fluid.

Theſe Veſſels, after many *Anaſtomoſes* and Diviſions that they have form'd, as ſmall Iſlands thro' the whole Meſentery, join to the Glands that are ſcatter'd between the two *Laminæ* that form it. They ſurround them; they are inſinuated there; they iſſue out from thence leſs in Number, but with more Valves.

There is no Separation in the Chyle, when it is in theſe Glands: This may be prov'd, 1*ſt*, By the Glands being cavernous. 2*dly*, That the Arteries creep above and below, and are not gather'd in Knots as in other Places. 3*dly*, That the Lymph of ſeveral *Viſcera* is gathered there. 4*thly*, Becauſe that the Arteries filtrate ſome Liquor, which they depoſite in the Cavity of thoſe Glands: for *Cowper* has obſerv'd, that Injections of Mercury paſs from the Arteries into theſe Glands: it may be that the Nerves diſcharge ſome Fluid there.

After the Chyle has been diluted in thoſe Glands, it runs thro' the Lacteals of the ſecond kind, which are leſs numerous, but thicker: Theſe Veſſels run into the Reſervoir diſcover'd by *Pequet*, the Hiſtory of which we'll give as well as we can. *Aſellius* diſcover'd the Lacteals; he imagined, as *Thomas Bartholin*, that theſe Veſſels crept into the Liver; but *Pequet* at laſt demonſtrated in the Year 1651, that the Lacteals went into a Receptacle, where they poured out the Chyle. *Bartholin* ſhew'd it at *Hanau* in 1552, and *Vanhorre* at *Leyden* in the ſame Year.

It is not to be doubted but that the greateſt Part of the Chyle mounts to the ſubclavian Vein; but we may doubt whether there is not a Part of it that flows into the Liver by the meſaraic Veins. *Bilſius* demonſtrated, that if we tied the Arteries of the Meſentery of a Dog who but juſt before had been eating, we find the Veins fill'd with a cineritious Fluid. Some have complained, that *Bilſius* did not give a juſt Account of the manner of his making Experiments; but *Gliſſon* gives it exactly. *Swammerdam* has confirm'd *Bilſius*'s Opinion by the comparative Anatomy. It is certain that in Birds there is a Paſſage to the meſaraic Veins: If we can ſuſpect that the Chyle paſſes from the Meſentery into the meſaraic Veins, may we not be of the ſame Opinion concerning the Stomach? Can the moſt ſubtile Part of the Aliments not be abſorb'd by the venal Tubes? Don't the Action of Cordials appear to be a Proof of this?

This Receptacle is ſituated at the Center of the Meſentery towards the *Vertebræ* of the Loins between the Muſcles, *Pſoas*, and Kidneys. *Cowper* has obſerv'd it to be treble: it is ſituated in a Human Body tranſverſly upon the Spine; it is oval and pyramidal in other Animals: it forms in them a Veſicle divided into many Cells; but in Men the Sides are ſtronger. It is in a manner glandular, and ſometimes divided into three Chambers, as we have already obſerv'd. It is more or leſs conſiderable, according to what Men eat, more or leſs. It is four times longer than the Thoracic Duct. It is in that Reſervoir that the Lymph of almoſt all the Parts under the Diaphragm is ſecreted.

REMARK IX. *Of the Thoracic Duct.*

THE Chyle having been diluted by the Lymph in the Reſervoir is protruded upwards, 1*ſt*, By the Action of the Diaphragm: in Inſpiration the Tendon of the Diaphragm, which lies upon the Reſervoir, ſuffers the Chyle to enter therein, becauſe it bows and becomes perpendicular on the Spine; but in Inſpiration it riſes, and is applied to the Spine, and ſo preſſes the Reſervoir. 2*dly*, The Chyle is protruded by the Action of the arterial Veſſels; for the Reſervoir is placed partly under the deſcending *Aorta*, and partly under the intercoſtal Arteries; therefore at every Pulſation of the Heart the Chyle muſt be protruded. 3*dly*, The Muſcles of the *Abdomen* that preſs the Inteſtines the ſame as the circumambient Air, muſt occaſion the Aſcenſion of the Chyle. 4*thly*, The elaſtic Force of the Membranes that ſtill ſubſiſts in dead Bodies produces the ſame Effect. While all theſe Forces act, the Chyle aſcends towards the ſubclavian Vein; for Fluids tend towards the Places where they find leſs Reſiſtance. The Valves and the Chyle that come from the Lacteals hinder its Return: The Chyle therefore muſt tend towards the ſubclavian Vein; there it opens the Valve that cloſes the *Ductus Toracicus*, permits the Chyle to paſs, and hinders the Blood from entring.

In the time the Chyle runs thro' the Inteſtines, all that can there be obſerv'd is reduced to four Heads.

Firſt, There is a very ſlow Motion in the Inteſtines, Lacteals, and Glands; the looſe Membranes of the Inteſtines can give but little Rapidity to the Fluids; the numerous Ramifications of the Lacteals can carry the Chyle but very ſlow: if it were contained in one Canal only, it would the ſooner enter the Maſs of Blood. In a word, as the Glands are ſo many ſmall anfractuous Cavities, wherein the Chyle enters from a narrow to a lager Place, their Number muſt retard that Fluid. In all theſe Reſervoirs the Chyle beaten by the Membranes is purified, ſince the thin Parts are ſeparated from the groſs ones.

Secondly, Nature requir'd that the Chyle ſhould remain a long while in the Meſentery, that it might be more fit to be mixed with the Blood; for which Reaſon it paſſes thro' an infinite Number of ſmall Tubes. The Union of the Lacteals, their Separation and Re-union, follow'd by others, confirm all this.

Thirdly, The Chyle being diluted in the Meſentery by the Concourſe of Lymphatics which furniſh it with Lymph that is filtrated in the *Viſcera*, perhaps the Glands afford yet a Spirit that comes from the Nerves.

Fourthly, The Chyle being divided, mixed with the Subſtance that flows from the Noſe, ſalivary Glands, Stomach, Liver, Pancreas, and Lymphatics, become proper to repair the Loſſes made by Tranſpiration in nouriſhing the Parts.

The Chyle is entirely like Emulſions; when we preſs out the Juice of Vegetables the Lymph mixes with the Oil; from this Mixture the Chyle is form'd. The Inſpection of this Fluid by a Microſcope offers nothing contrary to this Idea. It appears that Emulſions are compoſed of an infinite Number of Globules that ſwim in the Water: the ſame thing is in the Chyle. We have already taken notice of this, but we have not yet explain'd how theſe Globules are form'd; perhaps they are nothing elſe but the oily Parts, that, not joining with the Water, are preſſed on all Sides, and conſequently muſt take a round Figure. We obſerv'd fibrous Parts between thoſe Globules and that Lymph, as we do in the Blood: In a word, the Difference the Microſcope diſcovers between the Chyle and the Blood is, that in the Blood there are many oily Globules united together.

Dr. *Pitcairn* asks, What Subſtance of the Vegetables is it that is changed into Chyle, whether the fibrous or fluid? And he juſtly anſwers, that it is only the fluid: 1*ſt*, Becauſe the fibrous Parts are found in the *Fæces*. 2*dly*, Becauſe theſe Solids cannot be diſſolved in the Stomach. 3*dly*, That even if they were diſſolved, their Bigneſs would hinder them from entring the lacteal Veſſels.

REMARK XV. *Of the Lymphatics.*

IT is doubtleſs that the Blood is carried in the Parts by an Artery, and returns by two Veins, the one brings back the red, and the other the aqueous Part or *Serum*; but the Origin of lymphatic

Veſſels has not yet been clearly demonſtrated. There are Anatomiſts who believe, 1*ſt*, That the Blood is poured from the Arteries into the Pores or fleſhy Fibres. 2*dly*, That it is in theſe Spaces that the lymphatic Veins and Veſſels open. 3*dly*, That the red Part, which is the groſſeſt, paſſes into the Veins which are larger, and that the *Serum* enters into the Lymphatics.

Other Anatomiſts aſſert, that the arterial and venal Veſſels are inoſculated, that in the Meetings of the Arteries and Veins theſe Veſſels are pierced with an infinite Number of ſmall Holes, that it is thro' theſe Holes that the Lymph paſſes, or thro' the ſmall *Papillæ* that are form'd by the arterial Ramifications that are infinitely ſmall.

The firſt Opinion is prov'd by the Microſcope; in the Spleen, for example, we ſee that the Arteries environ'd by fine Cotton-like Tufts enter into the Cellules, the arterial Extremities float in the Blood that they pour in the Cellules: if we inject warm Water in the Arteries to waſh them, and take away the grumous Blood, and blow thro' the Vein, the Lymphatics inflate; all that we can aſſure, is, that Veſſels in the Spleen are not continued. As for the *Penis*, it is certain; but the ſame Defect of Continuity is found in the *Sinus's* that are on the Side of the Saddle; the Blood flows there, and forms a kind of Moraſs: but whether this is ſo in other Parts has hitherto not been prov'd.

Mr. *Nuk* diſcover'd theſe Veſſels in almoſt all the Parts of a Human Body. *Vieuſſens* ſays, that the Extremities of the Nerves concur with the Lymphatics that bring the nervous Juice into the Blood: but this could not as yet be diſcover'd.

In the external Parts there are a vaſt Number of Lymphatics that render our Skin white; but theſe Lymphatics are not like the precedent ones: The Arteries ſend Ramifications where the Blood can't enter: in theſe little Branches the Lymph enters, which without doubt muſt return thro' the Veins that anſwer to ſmall Arteries.

When the Parts are enflamed, the Blood paſſes in thoſe Veſſels that receive the Lymph. 1*ſt*, We obſerve in an Inflammation, that the white Parts become red; the inflated Arteries ſeem not able to produce that Effect. 2*dly*, When the Eyes are enflamed, it is undeniable that then the Lymphatics receive the red Part of the Blood. 3*dly*, By injecting a thin Liquid we colour all the Skin. 4*thly*, The Stoppage of the Blood in the Arteries can produce no Inflammation, ſince in Scars it is always ſtopped; in Amputations we cut away many arterial Veſſels, yet doth the Blood occaſion an Inflammation when the Part is cured, altho' many Veſſels are cloſed up.

The lymphatic Veſſels of the *Viſcera* enter into the thoracic Duct, in the Reſervoir, and Meſentery; in other Places there are Glands that are as Repoſitories: theſe are call'd *Glandulæ conglobatæ*. There are Lymphatics that bring the Lymph there, and others that retake it to conduct it to the Blood. *Thomas Bartholin*, who was of opinion that they had no Communication with the Lymphatics of the Members, is refuted by Inſpection only. Thoſe who believ'd that the Lymph came from the Nerves into thoſe Glands, to re-enter into the Blood, have no better a Foundation. Behold the Structure of theſe Glands.

There are Anatomiſts who are of opinion, that thoſe Glands are but a continu'd Clew of capillary Veſſels and Arteries: But if we examine them cloſely, their Structure would appear quite different; in the exterior Side there are two Coats, the internal is thick, and compoſed of fleſhy Fibres that are interwoven in different Ways; they receive laterally arterial Veſſels that moiſten them;

inwardly we find many fleſhy Fibres ſituated tranſverſly; theſe Fibres embrace many Veſicles that are fill'd with Lymph, and it is thoſe Veſicles that make the Surface of the Glands unequal: the Fibres that enter into the Gland reſemble, according to *Nuk*'s Opinion, the Moſs of Trees. *Malpighi*, who has given us the Structure of theſe Glands, aſſerts that there are Nerves that enter into the Body of the Gland. He tells us moreover, that *Nuk* has given a very falſe Deſcription of thoſe Glands, when he only perceived Spaces with a ſort of Moſs between the fleſhy Fibres.

Bergerus looks upon thoſe Glands to be as ſo many ſmall Hearts that preſs the Lymph, and ſubtilize it by their Motion. *Bohn* obſerved, that the Lymph ſecreted by thoſe Glands is tranſparent: whereas, when it enters them it is like Milk. This proves that the Preſſure of thoſe glandular Bodies has made there a great Change, in order to facilitate this Preſſure: according to *Bergerus*'s Opinion, Nature has placed ſo many Nerves in thoſe Glands.

The Lymph contain'd in the Blood or in the Veſſels that are deſtin'd for it, is not an homogeneous Body: it is compoſed, 1*ſt*, of an aqueous, 2*dly*, of a fibrous Part, 3*dly*, of Globules. When it is expoſed to the Fire, the fibrous Parts unite, and form a thick and whitiſh Matter. There is no doubt but that this fibrous Part forms the white Cruſt upon the Blood in a Pleuriſy: the vaſt Heat that happens in thoſe Places where it is ſtopped, thicken it more, and augment the Obſtruction. This fibrous Part is nothing but an oily Part of the Lymph; this can be prov'd in ſeparating and drying it. It is not neceſſary that I mention any thing which it affords by chymical Analyſis: there is drawn from it Phlegm, *Sal Volatile*, and an empyreumatic Oil. It is neither Acid nor Alkaly.

It is the Lymph that cauſes Dropſies; we commonly find the Liver, Kidneys, and Meſentery, ſchirrous, or dried, or in ſome other manner obſtructed: but we often find Dropſies wherein theſe *Viſcera* were not affected. Dr. *Lower* gives us an Experiment which ſhews us the Cauſe of a Dropſy: After having ty'd the Jugular of a Dog, he obſerv'd that the upper Parts of the Ligature ſwell'd, that the *Saliva* and Tears flow'd abundantly. He tells us alſo, that having tied the *Vena Cava*, all the *Abdomen* was fill'd with Water. It appears alſo, that in Dropſies that proceed from Obſtructions of the Meſentery, the lymphatic Veſſels are ſwell'd.

REMARK XVI. *Of the* Pancreas.

BEhind the Stomach, at the right Side, and under the Pit of the Stomach, there is a conglomerate Gland; it enters the two *Laminæ* that ſerve to form the *Omentum*, and is diſcharged into the *Duodenum*. This Gland, altho' unknown to the Ancients, has given room in our time for great Diſputes: I won't mention the Opinions that ſuppoſe that from the Inteſtines there enters ſome Fluid in the pancreatic Duct. It is certain that the *Pancreas* ſends a Fluid to the *Duodenum*. As its Canal runs ſome Space between the Membranes of the *Duodenum*, nothing can enter the Inteſtines. As for thoſe who were of opinion that the *Succus Pancreaticus* was an Excrement of the Liver; thoſe, I ſay, believ'd without Foundation. The Opinion that has been moſt embraced is that of *Sylvius de le Boe:* he advanced that the *Succus Pancreaticus* was acid, and fermented with the Bile. 1*ſt*, That Juice is almoſt inſipid, and if it has any Taſte is ſaltiſh: what Experiment ſoever is made, it is not found to be alkaline or acid,

acid. The Experiments that ſeem to prove its Acidity are tried upon a Juice that is not freſh, or which is preſſed out with Violence. 2*dly*, It ferments not with Bile. To prove this Fermentation they tied the *Duodenum* above and below the *Ductus Pancreaticus*, and found the Space that was between the Ligatures inflated: this proceeded from the Heat that in that Space rarefied the Air. By all this we can ſee what we muſt think of the Opinion of *Sylvius de le Boe*, who attributed all Maladies to the Mixture of the Bile, of that Juice, the *Saliva*, and the Juice of the Stomach. It is without Reaſon we diſtinguiſhed this Juice from the *Saliva*, from the Juice of the Stomach, and Inteſtines. Theſe Fluids are the ſame, they are nothing but a Water join'd to very much attenuated Oil and to a Salt; therefore we will ſpeak of it more at large in treating of the Blood and Fluids it contains. The *Succus Pancreaticus* is of Service in Digeſtion, it diſſolves gummy, ſaline, and mucilaginous Subſtances, it dilutes and ſweetens the Chyle, divides the Bile that without doubt would be heated too much, and would be very acrimonious; it is therefore diſcharged in the ſame Place with the Bile: by theſe Uſes it ſeems that it is abſolutely neceſſary; nevertheleſs, the *Pancreas* of Dogs has been taken away, and yet they liv'd after it; but they did not take away a ſecond *Pancreas*, which is fixed on the Inteſtine *Duodenum* in Dogs as in Men: therefore Diſputes that were occaſion'd by theſe Dogs depriv'd of their *Pancreas* are not juſt. Nevertheleſs, if a great deal of Juice is filtrated in the Ventricle, it ſeems the pancreatic Juice would not be of abſolute Neceſſity.

After having ſeen the Uſe of the *Succus Pancreaticus*, we muſt ſee by what Force it is made to flow. 1*ſt*, As the Artery that carries the Blood to the glandular Body is near the Heart, the Impulſion of the Blood is very conſiderable; ſo, as the Blood always furniſhes new Juice that is filtrated, the firſt that was filtrated muſt neceſſarily flow. 2*dly*, That Juice which flows from the ſmall Glands thro' little Canals that terminate on a Canal that is in the middle, is preſſed out in the *Duodenum* by the Motion of the Diaphragm, by the Preſſure of a full Stomach, by the Force of the Muſcles of the *Abdomen*, and laſtly by the Action of the Body.

This Juice may cauſe many Indiſpoſitions. 1*ſt*, If it remains too long in the *Pancreas*, it will alkalize as all the Fluids of the Human Frame. 2*dly*, If it is too abounding, it will retard the Action of the Bile, and therefore the fat Subſtances will not be able to diſſolve. 3*dly*, If it is obſtructed, the Bile will be too acrimonious, it will heat the Air and rarefy it, and will be able to cauſe *Diarrhœa's* and Dyſenteries. It was believ'd that the Cauſe of intermittent Fevers was in the *Pancreas*; and this Opinion was founded on that. This glandular Body was found obſtructed in Subjects who died of theſe Fevers: but it ſhould have been prov'd before, that theſe Obſtructions were not the Effect of Fevers. Certainly an obſtructed *Pancreas* may be the Occaſion of conſiderable Diſorders; we may judge of it by the Quantity of Fluid that is there filtrated, and by its Neceſſity in Digeſtion. If the excretory Ducts cloſed, permit no Fluid to go out, the Veſſels will be more fill'd in the reſt of the Body, in the *Pancreas* might enflame, on the other Side the *Duodenum* will no more receive the Fluid that is neceſſary for it to dilute the Chyle, and to precipitate the Excrements.

REMARK XVII. *Of the Liver.*

THE Liver, properly ſpeaking, is nothing but a continued Maſs; but by reaſon of the great Inciſure that is in the middle in the inferior Part, Uſe requires its Diviſion into two Lobes; the right Lobe is the largeſt; the left, which is the leſſer, lies upon the Stomach, which it covers as far as the left *Hypochondrium.*

The ſuperior Surface is ſmooth and convex; it is divided into two by a Ligament that riſes from the middle, from the poſterior Part to the anterior. This Ligament is membranous, and ties the poſterior Side of the Liver to the Diaphragm.

Under the common Membrane is the proper; between the two Membranes there appears the cellular Subſtance, upon which creep the Lymphatics. *Ruyſch* has demonſtrated, that this Subſtance is found in all the Duplicatures.

The inferior Surface of the Liver is concave and unequal; it is parted in two by the large Inciſure: there are many Eminencies there. We have already taken notice of *Spegellius*'s Lobe, which is towards the poſterior Part in the right Lobe. I omit the other Eminencies and Cavities, for Inſpection alone can give us a true Idea of them.

The Liver, as we have juſt mention'd, is join'd to the Diaphragm; the *Vena Porta*, riſing from the Ramifications that come from the Inteſtines and other *Viſcera* of the *Abdomen*, is inſerted between the Tubercles that leave the Space the Ancients call'd *Porta*, cover'd with a ſtrong fibrous Membrane reſembling the Coat of the Arteries: it is found in a Caſe that goes by the Name of *Capſula Gliſſonii.* After it has run half an Inch, it forms a very large Sinus, where the Blood is retarded a little in its Courſe, becauſe it enters from a narrow Canal to a broad one: it is triturated by the Action of the Diaphragm and Muſcles of the *Abdomen.*

This Sinus, ſituated tranſverſly, ſends out Branches that in their Courſe are always accompanied, 1*ſt*, by Ramifications of the biliary Duct, 2*dly*, by Ramifications of the hepatic Artery, 3*dly*, by Nerves. The common Membrane, as we have already mention'd, covers all this Collection with the *Membrana propria*; but the *Capſula Gliſſonii* enters the Liver by Extenſions that accompany and embrace the Nerves, Veſſels, and biliary Ducts, that are ſo cloſely fixed there, that they can ſcarce be ſeparated. The *Vena Porta*, or the Sinus, is divided into five principal Branches, that afterwards are divided into other leſſer like Arteries. Theſe Ramifications, always cover'd by their *Capſula*, are expanded every where, and form almoſt all the Subſtance of the Liver. The hepatic Artery, inſerted in the *Capſula*, is divided in the ſame manner as the *Vena Porta*, and is expanded every where: others, that ariſe from the Diaphragm and *Ligamentum Suſpenſorium*, are join'd to it: ſome ariſe from the cyſtic Arteries.

The *Vena Cava*, that comes from the inferior Parts towards the Diaphragm, is inſerted in the Liver, it being placed in a Fiſſure poſteriorly. Sometimes, and eſpecially in Animals, the Subſtance of the Liver covers it on all Sides. At its Inſertion it is pierced thro' by many Holes that are Openings of the Ramifications that ariſe from the Liver: there are pretty large Branches. Theſe Veſſels, that have been form'd by the Concourſe of an infinite Number of ſmall Tubes, carry back into the *Vena Cava* the Blood that remains after the Bile had been filtrated. Theſe ſmall Tubes ſeem to be leſs numerous, and to have leſs Capacity than the Ramifications of the *Vena Porta.*

In all Places where the capillary Extremities of the *Vena Cava* and *Porta* form ſmall *Faſciculi* of an admirable Structure, and are in Figure like ſmall Pencils, there appear ſmall diſtinct Globes that ariſe from Veſſels almoſt inviſible; they reſemble that which we call Simple Glands: the ſmall Lobes are compoſed of theſe Globules, and the great Lobes are formed by the ſmall Lobes, and the great Lobes at laſt form the Liver. The Inſpection of the Liver of Inſects, Fiſh, Birds, and Quadrupedes, the Progreſs of the Liver in its Origin, Injections, and Diſeaſes, are a Proof of it: and this is confirm'd by the Microſcope.

At the Extremity of the Ramifications of the *Vena Porta* and *Cava*, there are very ſmall Tubes that iſſue out of thoſe ſmall Globules by an inviſible Origin; they follow all the Ramifications of the *Vena Porta*, covered by the ſame Coat: at laſt, growing always larger by their Junction, they meet in the ſame Canal at the Trunk of the *Vena Porta*. It is the *Porus Biliarius* that carries the Fluid to be filtrated in the Liver.

In the Sinus of the *Vena Porta* is inſerted the umbilical Vein, which carries, 1*ſt*, The Milk filtrated in the Womb. 2*dly*, The Blood that flows from the Infant to the *Placenta*, at the oppoſite Part of the Sinus, is the *Canalis Venoſus*, that is diſcharged into the *Vena Cava*: it is by theſe means that the Blood arrives at the *Fœtus*; Nature thus ſhortning the Courſe of the Blood, and making it paſs almoſt immediately from the umbilical Vein into the Heart.

Is the Bile filtrated by the Ramifications of the *Vena Porta*, or by thoſe of the hepatic Artery? The Authors who have affirmed, that the Bile proceeded from Arteries, produced no Reaſons for it. 1*ſt*, The oily Matter of the *Epiploon* that is thrown into the *Vena Porta*: 2*dly*, The chylous

Subſtance that flows into the meſaraic Arteries: *3dly*, The Fluid contain'd in the *Porus Biliarius*, that is an Oil very much exalted by Heat: *4thly*, The Ligatures made at the *Vena Porta*: *5thly*, Injections made in the Liver, which ſhew Fluids injected thro' the *Vena Porta*, make their Way thro' the *Porus Biliarius*, and not like thoſe injected by the hepatic Artery. *6thly*, The ſtrong Union of the Ramifications of the biliary Duct and *Vena Porta*: *7thly*, The Diſproportion between the Ramifications of the biliary Duct and thoſe of the hepatic Artery, which are leſs both in Bulk and Number: *8thly*, The arterial Diſpoſition of the *Vena Porta*: All theſe Reaſons plainly demonſtrate, that the Bile is filtrated in the Extremities of the *Vena Porta*. We may add to all this, that in inflating the *Vena Porta*, all the Veſicles burſt, and the Air enters the Space that is between the proper and common Membrane.

As for the Reaſon why the Bile is ſeparated rather from Veins than Arteries, *Borelli* ſuppoſed that it returned into the Liver by the meſaraic Veins. Amongſt all the Inconveniencies found in this Opinion, it is plain that it is nothing but a mere and groundleſs Suppoſition. No other Reaſon can be given for this *Phænomenon* than, *1ſt*, The Difference of the Strainers: *2dly*, The Difference of the Motion of the Blood, which is very ſlow in the Liver: *3dly*, The Affluence of oily Matter that proceeds from the *Epiploon*, and perhaps a chylous Subſtance: *4thly*, The Blood that has loſt its Lymph in the Meſentery contains much Oil, which it depoſits in the Liver.

The *Vena Porta* has no Pulſation: It was aſſerted, that the *Capſula* that fortified it could propel the Blood: but this is but a very weak Support. *1ſt*, It is certain that the Veſſels of the Liver ſink not as much as thoſe of other Parts; we find thoſe Veſſels always open and contracted in dead Bodies; they are ſurrounded by a Matter to which they are fixed, and cauſes them to be firm. 2*dly*, The Ramifications of the hepatic Artery having a continual Pulſation. 3*dly*, The Muſcles of the *Abdomen* and Diaphragm. 4*thly*, The Blood continually propel'd by that which follows. This ſuffices to give a progreſſive Motion to the Blood. In Men, at the concave Part of the Liver, is ſituated the *Veſicula Fellis* or Gall-Bladder; it is of an oval Figure made up of divers Membranes; the external is common with the Liver: the ſecond is compoſed of the *Subſtantia Celluloſa*, the third is muſcular, the fourth nervous, the fifth is a *Tunica Villoſa*, reſembling Honey-Combs. The Gall-Bladder becomes narrower towards its Neck; it is very much like the Head of a Bird, of which *Ruyſch* has given us a perfect Delineation; the Beginning of the Beak is tortuous in the external Part; in the internal there is a Valve perfectly ſpiral. The ſame Anatomiſt has likewiſe obſerv'd Branches of the *Vena Porta*, that enter into the Gall-Bladder; they terminate in a ſort of Points which are more numerous towards the Neck; they are called Glands. As for the Roots that the eminent Mr. *Cheſelden* takes notice of towards the Bottom, they are not to be found, according to *Bergerus*, in what manner ſoever the Bladder is examined; but they appear, if a great deal of Care is uſed in Diſſection. The Canal that comes from the Beak joins to the *Porus Biliarius*, with which it forms an acute Angle. Theſe two Canals join'd together form a larger Canal, deſcending obliquely, and inſerting into the *Duodenum*, which it cuts in an acute Angle: it enters firſt under the external Coat; being deſcended under that Coat, it then pierces the ſecond, and runs a great way between the ſecond and third: at laſt this Tube opens thro a large Hole in the Cavity of the Inteſtines; it does not always afford Bile. It is certain, that when the Inteſtines are in Contraction the Hole ſhuts, and it opens only when they are relaxed. The Chyle cannot enter there, becauſe the Canal ſituated under the third Coat is always ſqueezed down by the Contents of the Inteſtines: beſides, the Orifice which is floating is compreſſed by all that offer to enter.

This Structure, if compared with that juſt now mention'd, will make it appear that the Bile comes, 1*ſt*, From all the Parts of the Liver thro' the *Ductus communis*, in order to enter the Inteſtines. 2*dly*, From the *Veſicula Fellis*, or Gall-Bladder: there was found a Subject without the Gall-Bladder, inſtead of which there were many ſmall biliary Cells, which were form'd by the Union of ſeveral biliary Canals: from theſe Veſicles the Bile was carried to the Inteſtines by ſome ſmall Tubes. This confirms the Uſe given to the Gall-Bladder.

There are biliary Canals ariſing from the Veſſels, Liver, and hepatic Canal, in order to enter the Bladder. The Bile drops into the Bottom of the Bladder thro' theſe Canals, from whence it enters the cyſtic Canal, in order to enter into the *Cholydocus*.

The Bile enters from the hepatic Canal to the cyſtic. 1*ſt*, The Obliquity that appears in the cyſtic Canal ſeems to prove the contrary; it appears that the Bile ought to enter the largeſt and moſt open Canal. 2*dly*, Comparative Anatomy ſeems to prove the ſame. *Borrichius* has obſerv'd in Eagles, that the *Ductus Hepaticus* is inſerted firſt in the Inteſtine, then ariſe two pancreatic Ducts, after theſe the cyſtic. *Blaſius* has obſerved in Ducks, that theſe two Canals enter the Inteſtine far from one another: the ſame has been obſerved in the Peacock. But, 1*ſt*, in order to compare one

Obſervation with another, the Gall-Bladder is entirely ſeparated from the Liver in Serpents; it hangs at the *Porus Hepaticus*, at a pretty Diſtance from the Liver: Hence it is evident that the Bile muſt neceſſarily enter the Gall-Bladder from the *Porus Hepaticus.* 2*dly*, Experience teaches us, 1. That Injections flow from the Cavity of the Gall-Bladder into the Liver, *Porus Biliaris*, and Inteſtines. 2. The *Porus Hepaticus* into the Bladder, the cyſtic Canal, and in the Inteſtines. 3. From the hepatic Canal in the cyſtic, and from the cyſtic into the hepatic. I refer the Reader to the Experiment made by *Ruyſch* and *Bohn*; by which it appears, that the Bile can take that Courſe. Theſe Phyſicians having tore the Gall-Bladder of divers Animals as far as the Neck, have taken notice, that the Bile was diſcharged into the Neck; and after having tied the *Ductus Cyſticus*, they alſo obſerv'd, that the Bile was gathered between the Ligature and the Inteſtine. *Verheyen* anſwers, but upon no Foundation, that this comes from the Compreſſions or Obſtructions made by him that makes the Experiment.

In the Gall-Bladder there is filtrated a Bile as in the Liver. 1*ſt*, There are *Lacunæ*, or glandular Bodies in the Bladder. 2*dly*, There are Ramifications of the *Vena Porta* (as *Ruyſch* has demonſtrated) at the Bottom of the Bladder. 3*dly*, In blowing thro' the Liver, the Bladder is inflated thro' the Place where it is join'd to the Liver.

Backius and *Sylvius de le Boe* were of Opinion, that all the Bile was ſecreted in the *Veſicula Fellis*, and that it run partly in the Inteſtines, and partly in the hepatic Duct, thro' which it enter'd the Liver, in order to enter the Maſs of the Blood thro' the *Vena Cava.* 1*ſt*, The *Veſicula* is wanting in ſeveral Animals, as in Deer, Doves, *&c.* 2*dly*, The cyſtic Canal is not always join'd with the hepatic;

in ſeveral Animals it runs in the Inteſtines, without inoſculating by the Way. *3dly*, If we tie the cyſtic Canal, a Bile is filtrated in the Liver, that flows in the Inteſtines. *4thly*, The Inſertion of the cyſtic Canal in the hepatic is ſuch, that the Orifice of that Canal towards the Inteſtine, is Proof enough that it is deſtin'd to carry the Bile on that Side. *5thly*, The Situation of the *Veſicula Fellis* in Serpents utterly deſtroys that Opinion.

Munik aſſerted, that the moſt ſubtile Part of the Bile which is ſeparated in the Liver, re-enters the Blood by the Ramifications of the *Vena Cava*. *Bergerus* maintains, that this Reflux is contrary to the Structure of the Parts. Nevertheleſs, having given a Vomit to a Man who had a ſchirrous Liver, I obſerv'd that inſtantly after the Operation of the Medicine, the Patient became yellow: this could not ariſe but from the Reflux of the Bile that was heaped up in the Liver. Many were of Opinion, that the Bile was not ſeparated from the Blood, but from the Chyle: There is no Reaſon to prove this Opinion. *1ſt*, It may happen that a Part of the Chyle paſſes into the meſaraic Veins; nevertheleſs, the greateſt Part paſſes into the Receptacle of the Chyle and thoracic Duct. *2dly*, In ſtarved Animals there is great Quantity of Bile ſecreted.

The Bile ſecreted in the Liver and *Veſicula Fellis* differ, as we have already mention'd. *1ſt*, The Bile of the Gall-Bladder is thick, very yellow and bitter; it was thought that this Bitterneſs belongs to that Part of the Bile which is ſeparated in the Glands of the Gall-Bladder, and that it joins at laſt to that which is mixed there, and comes from the Liver; but we muſt alſo confeſs, that the Stay the Bile makes in the Gall-Bladder is the Cauſe of its bitter Taſte. *2dly*, The Bile which comes from the Liver is clearer, and is not ſo bitter as the other, if it makes no Stay in the Gall-Bladder.

The Motion of the Blood in the hepatic Artery, Reſpiration, the Preſſure of the Muſcles of the *Abdomen*, can preſs out the Bile from the Liver and Gall-Bladder; but when the Stomach*is full, then the Gall-Bladder being preſſed, muſt neceſſarily be emptied; yet we are to obſerve, that it never is emptied entirely, unleſs there happen extraordinary Convulſions that cauſe a great Preſſure in the *Viſcera*. This happens in violent Vomitings.

The Bile is nothing but the ſaline Matter of the Blood mixed with an oily Part and Phlegm. By this it appears, 1*ſt*, That it is a ſaponious Body; Experience alſo confirms it, becauſe there is no Soap that takes off the Spot of Clothes better. 2*dly*, That it mixes the Subſtances which it meets with. We know that Oil mixes not with Phlegm, but if we incorporate with it a Soap, the Oil will join to the Salt, and at laſt to the Water by means of the Salt, which, as is evident, unites with Water; the Colours that are made fluid with the Bile are a Proof of it. 3*dly*, That by its oily Parts it embaraſſes the Fluids, that may be too acrimonious. Chymiſtry teaches us, that the more the alkalized Salts are deprived of their Oil by the Fire, the more cauſtic they are, and that by Oil their Cauſticity is diminiſhed. 4*thly*, That it ſtimulates the Inteſtines, and preſſes out of it the Lymph. This appears by the Jaundice; in this Sickneſs the Body generally is coſtive, becauſe the Bile, which is not ſecreted from the Blood, cannot enter the Inteſtines. 5*thly*, That it is reſinous; for if we cauſe the Phlegm to be evaporated from it, it becomes a ſort of inflammable Roſin or Pitch, provided it be well dried. 6*thly*, That it can form Stones in the Gall-Bladder; in order to do which, the viſcous Matter muſt only adhere to a Kernel. The Bile becomes extremely viſcous by the long Stay it makes in the Gall-Bladder. We ſee by Experience, that if we put in the Gall-Bladder of a Dog a Piece of Cloth, there is a real Stone form'd round it by the Adherence of a viſcous Matter; yet it muſt be allowed, that there is a Difference between the Stone of the Bladder and Stone of the Gall-Bladder; for the Stone of the Bladder weighs more than Water, and is not inflammable; but the Stone of the Gall-Bladder ſwims in the Water, and is inflammable. In Bodies where Stones are found in the Gall-Bladder, I found the Bladder very large. In ſhort, the Stones of the Bladder are yellowiſh without; within there are found *Strata*, partly of a yellowiſh, and partly of a dark Colour. *7thly*, That *Vieuſſens* concluded, but without Reaſon, that the Sulphur of the Bile whitened the Chyle, and diſpoſed it to Fermentation: All theſe are but prejudiced Notions. We don't ſee that Soap whitens the Fluids: beſides, the Blood has no need of Fermentation.

We might ask, What Matter is drawn from the Bile by the Analyſis? but we cannot know its Nature by that; for the Analyſis diſunites the Principles of Bodies: yet we may anſwer, that we draw an impregnated Principle from a very penetrating Salt, fetid Oil, and urinous Salt. *Van Helmont* and *Sylvius* were of Opinion, that this Salt was alkaly: They ſaid to prove this, that the Bile colour'd the Syrup of Violets green. But that is no Proof; for the Waters, in *Latin* call'd *Acidulæ*, will produce the ſame Effect; yet the Acid dominates, and is manifeſtly there. The Bile is neither acid nor alkaline, as all the Liquors of the Human Body; but it has a very conſiderable elaſtic Force. *Schuyl* having tied the *Duodenum* of a Dog below the *Pylorus* and Orifice of the *Ductus Pancreaticus*, a little time after found the Space that was between theſe two Parts extremely dilated, juſt as the *Veſicula Fellis:* He ſays, that after he had made an Inciſion, there iſſued forth many little Bubbles with a great Noiſe. In a word, the Bile is a Fluid that is entirely changed by the Mixture of Acids, and becomes more fluid and finer by the Mixture of lixivious Salts.

From all we have ſaid, this may be the moſt eſtabliſhed: 1*ſt*, The hepatic Artery ſerves to nouriſh the Liver, to propel the Bile and Blood thro' their Canals; therefore it is divided and ſpread by a ſurprizing Art thro' the external Membrane of the Liver, as *Ruyſch* demonſtrated it. From its capillary Extremities ariſe lymphatic Veſſels, which run not to the *Vena Porta,* but to the Receptacle of the Loins. There are Veins that receive the Blood carried by the hepatic Artery, and carry it in the *Azygos,* on that Part which is under the Diaphragm.

2*dly*, The *Vena Porta* takes the Form of an Artery by its Ramifications, that become leſs; it not only takes the Form, but it even performs the Duty of an Artery, for it ſecretes, which is the Property of Arteries in all the reſt of the Body. Hence it follows, that the Blood in going from the Heart, and in entring the meſaraic Veins, was arterial and venous, becomes again, 1*ſt*, Arterial in the *Vena Porta.* 2*dly*, Venous in re-entring the *Vena Cava.* 3*dly*, The Motion of the Blood can be but very ſlow in the *Vena Porta,* for which Reaſon it was neceſſary for the Liver to be ſituated under the Diaphragm, and expoſed to the Action of the Muſcles of the *Abdomen*; the more theſe Muſcles act, the more the Bile will be ſecreted. Hence it happens, that if we remain long inactive, there is form'd in the Liver and Gall-Bladder a viſcous Humour, Stones and Worms. By all this it appears to how many Diſeaſes the Liver is ſubject. *4thly*, In the Liver there is a Concourſe of Veſſels of the Spleen, *Epiploon*, Meſentery, Inteſtines and Pancreas. Hence it is that the Diſtempers of the Liver have ſuch an Affinity with thoſe of all theſe *Viſcera*, and that it is difficult to cure them. The eminent Monſieur *Stahl* publiſhed a fine *Theſis*, where he ſhews the *Vena Porta* to be the Source of many Diſeaſes. If we only imagine an Obſtruction in the Ramifications of that Vein, how many Accidents may not happen to all the other *Viſcera* that ſend their Blood to it? We may likewiſe ſee by this what a Neceſſity there is for the Bile, ſince ſo many Parts conſpire to prepare it, in ſending the Blood from which it is ſecreted in the Strainers of the Liver. *2dly*, That this Fluid is prepared with more Art than thoſe that are filtrated in the reſt of the Body; for Nature has form'd very particular Strainers to ſecrete it, and the Blood has not the ſame Motions any where elſe, ſince (if I may ſo ſay) it repaſſes thro' a ſecond Heart, which is a Sinus; for the Blood return'd from the Body is gathered there, and makes its Exit from thence by four or five Ramifications. *3dly*, That the Liver was of abſolute Neceſſity, 1. To hinder the Oil's becoming acrimonious in the Meſentery, by the Heat and Privation of the Lymph, from entring into the Blood. 2. To furniſh a Fluid proper to diſſolve the fat Aliments, to excite Appetite, and to cleanſe the Inteſtines.

REMARK XVIII. *Of the Spleen.*

THE Deſcription of the Spleen is not leſs difficult than its Uſe: Anatomiſts are at great variance concerning its Structure.

The Spleen is ſituated in the left *Hypochondrium*, it hangs under the Diaphragm, adheres to the left

Kidney, *Omentum*, and in ſome meaſure to the Stomach. In this Situation it is expoſed to the Preſſure of the Diaphragm and the Muſcles of the *Abdomen*.

There are two Membranes; one common, that riſes from the *Peritonæum*, it does not ſlide upon the proper Membrane as in Animals: the ſecond is a proper Membrane.

From the firſt Artery, which is ſeparated under the Diaphragm from the great *Aorta*, there are many Ramifications that go towards the Spleen. The firſt Trunk of the Cœliac ſends it forth a Branch, the third ſometimes three. Very often from the Trunk of the *Aorta* there goes off an Artery that forms the Veſſels of the Spleen, and at the ſame time of the Liver, Pancreas, *Duodenum*, and Stomach. By this it appears that the Blood that goes to the Spleen is not different from the Blood of the other *Viſcera* from the lower Belly. Theſe Arteries, that are very large, and that by much ſurpaſs the Artery of the Liver, are diſtributed throughout all the Extent of the Spleen, are divided into an infinite Number of Ramifications, whoſe Extremities ſeem to be ſmall Glands.

Theſe Arteries are accompanied by Nerves that ſpread all over in a great Quantity; this ſhews that the Nerves have other Uſes beſides the moving of the Parts and rendring them ſenſible; for the Spleen has almoſt no Motion and no very lively Senſation. All theſe ſmall nervous Canals may to all appearance carry a Fluid to be mixed with the other venal Fluids that are in that *Viſcus*.

Theſe Veſſels and Nerves do not alone enter the Spleen. 1*ſt*, The *Epiploon* follows them into the Subſtance of the Spleen. 2*dly*, The proper Membrane and cellular Subſtance form Sheaths that accompany them in all their Ramifications.

Before we examine where all thoſe Veſſels terminate, we muſt talk of the Spleen of divers Animals. In Oxen, 1*ſt*, We are to remark tranſverſe Fibres that run from one Side to the other. 2*dly*, An Infinity of Cellules. 3*dly*, The Arteries that clear themſelves into thoſe Cellules, in ſuch a manner as that the Blood extravaſates there the ſame as in cavernous Bodies. 4*thly*, The Veins are inviſible after they have entred into the Subſtance of the Spleen. 5*thly*, When we blow in the Spleen by an Inciſion, the Air paſſes into the Veins. 6*thly*, When we blow thro' the Veins, all the Cellules are inflated.

This is what Anatomy ſhews us in Sheep, Moles, Hedgehogs, as well as in Oxen. In Men the different Diſeaſes, amongſt others the Tubercules, the Maceration of the Spleen, ſeem to prove that the Spleen has the ſame Structure as in other Animals. Neverthelefs, *Ruyſch* is againſt this Opinion; he demonſtrates (as he affirms) that the Injections paſs directly from the Arteries into the Veins. By this he proves that the Arteries do not terminate in Men as in Animals. Our Eyes are not fine enough to follow the laſt Ramifications. But this Anatomiſt believes, that the Veſſels by their Extremities form ſmall Pencils, that by an infinite Number of ſmall Tubes ranged around, repreſent a Bladder, eſpecially when the Artery is injected with cold Water. The tranſverſal Fibres, ſays *Ruyſch*, were neceſſary in Animals; the Furrows that are contain'd in the Spleen muſt be ſuſtain'd: But in Men, where there appears but a Continuation of Veſſels, there is no need for ſuch Bridles after the Spleen has been injected with Water in order to macerate it. When the Blood has been waſhed off the Fibres appear; but it is nothing elſe but empty Veſſels.

Notwithſtanding all theſe Reaſons, we may aſſert the Structure of the Spleen to be the ſame in Men as in Beaſts. *1ſt*, If we make an Inciſion in the Spleen, all the Cellules and Veins are inflated; but it would be impoſſible for this to be done if there was only a Continuation of Veſſels. *2dly*, With the Microſcope we may diſtinctly ſee wooly Cellules, in which the Blood is diffuſed. Theſe Cellules are no doubt form'd by the Sheaths that accompany theſe Veſſels.

If we tie the Vein of the Spleen of an Ox, and blow thro' the Artery, *1ſt*, There are ſeen, when the Spleen is dried, different Cellules, bent and inflated, that open one into another. *2dly*, In the venal Canals there are very large Holes that have a Communication with the Cellules, while the venal Canals are loſt by running farther. *3dly*, The Sides of the Membranes that form the Veſicles are moiſtened by arterial Veſſels. There is found all round theſe Membranes ſmall oval Corpuſcles white and numerous, that repreſent little Bunches of Grapes. Theſe little Bodies have been taken for Glands; but *Ruyſch* was of Opinion, that they were nothing but the Extremities of Arteries. *4thly*, According to this Structure, we may ſay that the venal Extremities perhaps receive the Blood, and that the lateral Holes that communicate with the Cellules, receive the Humour that is gathered in the cellular Receptacles.

If the Caſe ſtood thus in the Human Body, we might ſay that the Spleen is deſtin'd for the Filtration of the Lymph, and to ſend it back by the ſame Veſſels with the Blood. However, we may always aſſert, that the Structure of the Spleen is like that of the *Viſcera* in which there is ſome Fluid filtrated; conſequently there is there perform'd ſome Secretion: yet there are no excretory Veſſels to be found. The lymphatic Veſſels that meet together in the Spleen creep only between the two Membranes; they do not penetrate into the Subſtance of the Spleen, nor ariſe from all thoſe arterial Extremities that are diſcharged into the Cellules, but only from Arteries that nouriſh the Spleen: In ſhort, thoſe lymphatic Veſſels are fewer in Men than in Animals. Thus we may ſee what may happen in the Spleen. 1*ſt*, The arterial Blood fill'd with Lymph prepares that Lymph, filtrates it, ſends it in the Cellules that we mention'd, by particular Tubes, and perhaps throws a Part in the ſplenic Vein. 2*dly*, The Blood that remain'd after this Filtration is received back by the venal Orifices. 3*dly*, The Arteries perhaps that line the Cellules pour a prepared Blood full of Lymph in the Cellules: it happens thus in the Cellules of the *Corpora Cavernoſa* of the *Penis*. 4*thly*, We may conjecture, that the Nerves bring a particular Fluid in all thoſe Receptacles.

After the Blood has ſuffered theſe Changes by the Action of the Fibres of the Spleen, by the Contraction of the Diaphragm, of the Muſcles of the *Abdomen*; it is more ſubtile, more fluid, more ſpirituous, and redder when retaken by the ſplenic Vein: it is evident that all theſe Effects are produced from what we have already ſaid; but we do not very clearly ſee the Reaſon of it. Nevertheleſs, as all the Blood is ſent to the Liver, it is very likely that it is in order for the Secretion, which is perform'd in the *Viſcus* that the Spleen has been form'd in. Here are a few Experiments, which we may explain, by what we juſt now have mention'd: 1*ſt*, It is to be obſerv'd, that the Liver is enflamed ſometimes in Animals that have no Spleen; this proceeds from nothing but when the Liver is depriv'd of that vaſt Quantity of Lymph that comes to it from the ſplenic Vein.

2*dly*, It has been obſerved that Animals that have been depriv'd of their Spleen, piſs'd often: this proceeds, becauſe the Lymph that runs thro' the celiac Artery into the Spleen, is obliged to enter the emulgent Arteries that are at a ſmall diſtance from the celiac.

3dly, We perceive that Animals are much hotter when depriv'd of their Spleen; this muſt happen, if there is at that time filtrated in their Teſticles more ſpermatick Matter: but this proceeds, when the Blood in greater Quantity paſſes into the ſpermatic Artery. The Blood is thrown more abundantly in that Veſſel, by the ſame Reaſon as in the Arteries that go to the Kidneys. Let us call to mind their Situation.

4thly, Animals that have no Spleen are more voracious than others; the Reaſon of which muſt be this, if Digeſtion is perform'd ſooner, and if the Stomach and Inteſtines are ſooner evacuated; for this muſt be the Caſe, if the Blood that is the Cauſe of Contraction of the Stomach, and that pours the Lymph into its Cavity, is more abounding: The Situation of the celiac Artery demonſtrates this to be true. I omit the Grumblings of the Inteſtines, and Vomitings that happen on the firſt Days that follow the Extirpation of the Spleen. The Situation of the ſplenic and ſtomachic Nerves plainly ſhew that this muſt enſue.

5thly, The right *Hypochondrium* muſt appear more elevated, ſince that which elevated the left had been taken away; but this may be cauſed by the Augmentation of the Liver: As for that Augmentation, there is no other Reaſon to be alledged for it, than that a greater Quantity of Blood paſſes in the Artery that nouriſhes the Liver. Some would attribute this Growth to the Space that the Liver has to be extended when the Spleen is wanting: but were there no other Cauſe, the Liver ſhould always augment much; for when we eat, the Stomach and Inteſtines take up a greater Space; and when Digeſtion is performing, the Stomach leaves a great deal of room for the Liver: it is true that this may contribute ſomething to it.

By all theſe Reaſons hypochondriacal People, in whom the obſtructed Spleen doth not perform its Functions, muſt be ſubject to almoſt the ſame Symptoms as the Animals whoſe Spleen has been taken away. This is almoſt the ſame thing when the Spleen is wanting, or performs not its Functions. It is farther obſerv'd, that hypochondriacal People laugh much; the Adherence of the Spleen to the Diaphragm will give the Reaſon of theſe *Phænomena.* As for the Paleneſs, there are other Reaſons to be given for it; if it is but, 1*ſt*, That the meſenteric Veins, that are extremely bulky, retain a large Quantity of Blood. 2*dly*, That the too thick Blood cannot enter the *Corpus Reticulare* that colours the Skin.

We may judge by what we now have ſaid, if all that we have aſſerted concerning the Uſe of the Spleen is upon a good Foundation. Some were of Opinion, that the Spleen had no other Uſe but to ſerve as a Counterpoiſe to the Liver in giving Weight to the left *Hypochondrion.* But thoſe who reaſon ſo, are ignorant of the true Situation of the Liver, that covers the Stomach, and is thrown ſometimes very much upon the left *Hypochondrium:* beſides, what Neceſſity is there for that *Equilibrium?* Can it be ſaid that ſo ſmall a Body as the Spleen, in Conſideration of the Liver, can balance that *Viſcus?* Thoſe that were of Opinion, that the Spleen was but a uſeleſs Body, or a *Luſus Naturæ*, ſpoke with leſs Foundation; the Perfection found in the Structure of the Animal Body permits no ſuch Reaſonings: beſides, Dogs who have been depriv'd of that *Viſcus*, become melancholy, grow lean, have a viſcous Bile, a blackiſh and thick Blood.

There are Authors who thought that the Spleen was nothing but a Place where the *Fæces* of the Blood were depoſited; but what Reaſons have they brought to defend this Opinion? Imaginations and ancient Prejudices. I ſay the ſame of thoſe who placed the Seat of the vital Acid, which gives the Stomach its Action, in the Spleen. As for thoſe who advanced, that it was the Action of the Spleen, or of its Fluids, that occaſion the Motions that accompany Venery; 'tis plain by Experience that they are miſtaken, which teaches us that Animals depriv'd of their Spleens are hotter: The Ancients reaſon'd perhaps juſter, when they ſaid that the Spleen was the Seat of Joy.

While we don't reaſon upon the Principles drawn from the Structure of the Parts, we ſhall do nothing but form Syſtems that will never be of Conſequence. There is an Author, who thought to have made a great Diſcovery, in telling us that the Nerves that terminated at the Spleen, drew thence Animal Spirits, in order to carry it to the reſt of the Body; and that the Blood was carried in a great Quantity into that *Viſcus*, in order to be there perfected. Let theſe Ideas be examin'd by what we have already eſtabliſhed.

REMARK XIX. *Of the Kidneys.*

IN order to form an Idea of the Kidneys, we muſt firſt obſerve that they are covered by a Membrane common to the other *Viſcera*, which is in a manner floating; it may be raiſed and wrinkled like the Skin of a Dog: By blowing we may enflate the Interſtice that is between the Kidney and this Membrane like a Bag.

After this Membrane there appears the proper one; it may be divided into two: In the Interſtice we find a cellular Subſtance, which may be inflated.

flated. It is this Subſtance which, as we have ſaid, unites the ſeveral Duplicatures.

There proceeds from the *Aorta* a large Trunk on each Side, that on the right is longer than that of the left Side: we find the contrary in the emulgent Veins.

Theſe Veſſels being arrived at the Kidney, aſſume a Sheath; this Sheath is form'd by the proper Membrane, that entirely penetrates the Kidney, and follows all the Ramifications of the Veſſels, as *Heiſter* informs us. The Veſſels in entring into their Capſules form a Sinus; immediately after their Entry they are divided into ſeveral Ramifications: theſe Branches paſs directly to the Circumference of the Kidney, where by their Diviſions they form ſmall conglomerate *Papillæ*; from theſe ſmall Grains proceed the Veins that carry back the Blood; theſe Veſſels form a Curve, in order to regain the Center.

From the Concourſe of the Veins and Arteries, towards theſe glandular Bodies, there part long Tubes that meet together under the ſeveral Curvatures in the Form of Rays; theſe Rays or very ſmall Tubes meet towards the Center of the Arch, where they form by their Union pyramidal Bodies, that joining again to others, terminate into twelve *Mamillæ*: it is into theſe *Mamillæ* that the ſeveral ſmall Tubes we have juſt now mention'd collected together diſcharge themſelves.

There is a long Canal implanted in the Kidney, it is pretty large at its Entrance, and divides into ſeveral leſſer Tubes: thoſe ſmaller Tubes go on to embrace the *Mamillæ*, in order to receive the Urine that diſtils from them: the Concourſe of theſe Tubes, called *Calices*, is termed *Pelvis*.

As the arterial Veſſels ſerve to filtrate the Urine, ſome of them muſt likewiſe ſerve to nouriſh the Kidneys; and from this Blood deſtin'd to that, the great Quantity of Lymph that proceeds from the Kidneys, ſeems to take its Riſe.

The Kidneys are the Emunctories of the Body; there is no other Part that ſeems to receive the Urine: if we tie the emulgent Arteries, nothing is collected either in the Ureters or Bladder. Some Anatomiſts nevertheleſs are of Opinion, that there were other Ways. The Ligature of the emulgent Arteries doth not ſeem to them to be a convincing Proof; becauſe then the Convulſions and Diſorders that ariſe, ſhut the Strainers that are open when all is calm. Theſe are the Reaſons that make them doubt whether there are no other Canals that are diſcharged into the Bladder. 1*ſt*, The Mineral Waters paſs into the Bladder almoſt the very ſame inſtant they are drank: The ſame would happen to thoſe who drink much Wine. 2*dly*, The Water of dropſical People contain'd in the *Abdomen*, is emptied by Urine in the ſame manner as Abſceſſes of the Breaſt. 3*dly*, Gliſters ſometimes are voided thro' the Bladder ſoon after they have been in the Body.

Theſe Reaſons do not prove a Duct different from that of the Kidneys. 1*ſt*, Mineral Waters, the ſame as Wine, do not immediately iſſue out from the Ureters; it requires ſome time, becauſe they muſt paſs thro' the lacteal Veſſels, the thoracic Duct, the ſubclavian Vein, the *Vena Cava*, the right Ventricle of the Heart, the Lungs, the left Ventricle, *Aorta*, and the Emulgents; but when all that Space contains Mineral Waters or Wine, then we may obſerve, that we cannot continue drinking without continually making Water, ſince in the proportion that the Wine or Waters advance, a proportionable Quantity of Urine is diſcharged. 2*dly*, The Water of dropſical People may re-enter into the Veins by the abſorbent Tubes: Doth not the Water, when we bathe, enter our Bodies? Are there not Abſceſſes in the Extremities that are ſuddenly propel'd? For this could not happen if there were no abſorbent Tubes inſerted in the Veins; the Arteries could not receive them: for the Heart that there continually propels the Blood would oppoſe the Entry of the Fluids. It has been aſſerted, that the exterior Side permitted the Water to enter into the Cavity, and the interior did not permit it to iſſue out: for this Reaſon there have been Veſſels covered over with a Bladder, and the external Surface was placed outwardly: The Water, ſay they, that was poured upon that Veſſel, penetrated; the ſame doth not happen when the Membrane was applied to the Veſſel in ſuch a manner, that the external Surface anſwer'd to the Cavity. But this Experiment has not been ſucceſsful to all thoſe who tried it: beſides, Waters ſpread in the *Abdomen* are not emptied that Way; on the contrary, dropſical People make but very little Water. *3dly*, Gliſters can enter the lacteal Veſſels that have been found in the *Colon*; they can even paſs in the ſmall Inteſtines, provided the *Cæcum* be not inflated, for the Entry is not cloſely ſhut up but when the *Cæcum* is extended. After the Gliſters have paſſed thro' the Lacteals, they will be carried to the Kidneys thro' the common Way; it may even happen that they won't receive any great Change. We ſee that the Chyle has not been entirely changed five Hours after Meal. Notwithſtanding all theſe Reaſons, there may be ſome ſecret Paſſage that leads to the Bladder. The celebrated Monſieur *Winſlow* has diſcovered a Bag that reaches along the Spine, and terminates under the Stomach: Could not this Bag ſerve to carry the Urine thro' ſome Paſſage? Having ſeen that the Kidneys are the only Place where the Urine is ſecreted, let us ſee how it is filtrated.

The Blood propel'd in the emulgent Arteries dilates the Ramifications that are ſpread all over the Subſtance of the Kidneys: theſe Ramifications dilated compreſs the Blood that is contained in them, and propel it towards the Tube that they ſend to the *Mamillæ*; but as theſe Canals are narrower than the Extremities of the ſanguinary Arteries, they will not be able to recieve the red Part nor the thick Lymph. But, 1*ſt*, The aqueous Part will enter; for if we inject the emulgent Arteries with warm Water, the Water paſſes into the Veins, Lymphatics, and Ureters. *Malpighi* had no Succeſs in this Experiment: but the Reaſon is, becauſe he did not try it in a freſh Subject. The Air paſſes in the ſame manner in theſe Tubes as *Nuk* aſſerted. 2*dly*, The oily Part attenuated will make its Exit thro' theſe Tubes, and conſequently it will become a Fluid of a yellow Dye; for the Heat which has attenuated the Oil gives it at the ſame time a yellow Colour. 3*dly*, As the ſecretory Tubes of the Kidneys are larger than thoſe of the other Strainers, the terreſtrial and ſaline Particles can paſs there; it is alſo this that we ſee by the Sediment found at the Bottom of Urinals. By this it appears, if to explain the Secretion of the Urine we muſt have Recourſe to Ferments, Precipitations, or Opinions of infinite Numbers of Authors, who have abandon'd an eaſy Mechaniſm for Ideas that have no Experiment to confirm them.

The Blood is continually propel'd in great Quantities in the Kidneys, before it has been ſtripped of thoſe aqueous and oily Parts in the Strainers; it is neceſſary therefore that the Urine muſt be in great Plenty ſecreted in the Kidneys. The Blood that flows to the inferior Parts is there ſtripped of its aqueous Part, and of a ſubtile Oil. The Blood that enters the cutaneous Arteries leaves in the Strainers of the Skin the Matter of the

Sweat and Tranſpiration. It follows hence, that after reiterated Circulations there is leſs Water carried towards the Kidneys; and thus the oily Part which will be there depoſited, will be leſs diluted, and will grow yellower than the precedent, ſince its Parts will not be mixed with Water, that clears its Colour, and makes it fluid: beſides, the Heat this Oil had ſuffered thro' ſo many Circulations, will again give it a deeper yellow, and render the Salts more acrimonious: It is for this Reaſon, that when we have faſted a long time, the Urine becomes very yellow and acrimonious.

If the Blood is propel'd impetuouſly in the Strainers of the Kidneys by the Power of the Heart or Arteries, it would force the Ducts, that before received nothing but an aqueous and oily Matter attenuated, and conſequently we ſhould piſs Blood; and this happens in the ſmall Pox, in thoſe who have a Stone in the Kidney, in thoſe who have the renal Strainers very open or lax: but if it happened that the Arteries were very much inflated by the Blood, then would there happen a Suppreſſion of Urine; for the inflated Arteries would compreſs the ſecretory Ducts, and ſo conſequently would ſhut up the Paſſage for the Fluid there filtrated. In order to make Urine, there is a Neceſſity for a conſiderable Contraction of the Arteries; for while they contract, the Veins and excretory Ducts can be fill'd; which is the Reaſon that Opium ſtops the Urine: But if the Blood in ſwelling the Arteries hinders the Secretion of the Urine, the Tubes can there produce another Hindrance, by contracting. Hence it is that in hyſteric Fits the Urine is like Water; the Convulſions that contract the Nerves contract likewiſe the urinary Strainers. The ſame thing happens in inflammatory Diſeaſes, in Suppreſſions that ariſe from the Stoppage of the Kidneys.

Theſe Symptoms will go off by relaxing, by diluting Medicines, or Bathings, which always augment the Secretion of the Urine.

If there flows Blood in the Kidneys that is too thick, or that many terreſtrial Parts are preſſed againſt one another in the *Mamillæ*, it appears that Concretions may be form'd in the Tubes that filtrate the Urine: it is ſufficient that there is a Matter there ſtopt, that the oily Subſtance may ſtick there by *Strata*; for ſuppoſing grumous Blood or earthy Parts in the *Mamillæ*, the Oil that is viſcous would ſtop with thoſe Concretions, the enſuing Heat would cauſe the Fluid to evaporate, or the beating of the Arteries and Preſſure of the Muſcles of the *Abdomen*, would preſs it out; thus the dried Matter would form but a Maſs with thoſe Bodies which it met.

This is what happens in the Filtration of the Urine: In ſhort, when it is diſtilled out in Drops from the *Mamillæ* by the Preſſure of the Heart, Arteries, Spring of the Fibres, Muſcles of the *Abdomen*, Reſpiration, it is received by *Calices*, which are Branches of the Extremities of the Ureters; and either by its Weight or Urine that follows; or laſtly by the Preſſures now mention'd; it runs into a Canal, which we ſhall deſcribe after the following Section.

REMARK XX. *Of the* Capſulæ Atrabilariæ.

THE Uſe of the *Capſulæ Atrabilariæ* is as yet unknown, their Structure affords us no Knowledge of them: *Malpighi* aſſerts, that if we cut them lengthways, they appear to be compoſed of long Tubes; theſe Tubes ariſe from the Circumference, and take their Origin from certain Follicles that ſuſtain the Veſſels and Nerves that there form a *Rete:* they advance towards the middle, and meet in a Sinus covered by a Membrane which has many Holes. From this Sinus there are Canals that are diſcharged into the Veins. *Vanden Euryce* has obſerved lymphatic Veſſels that enter there, and others that iſſue out, in order to go to the Reſervoir of the Chyle. *Riolan* believ'd, that the *Capſulæ* had no other Uſe than to ſtrengthen the *Plexus Reticularis*, form'd by the coſtal and ſtomachic Nerve. *Highmor* will have them to be of no Uſe but in a *Fœtus*. *Spigellius* aſſerts, that they ſerve to fill up the *Vacuum* between the Kidneys and Diaphragm. *Veſlingius*, with the Ancients, thought that they were the Source of the *Succus Atrabilarius*, which, according to his Opinion, ſeparates the *Serum* from the Blood. According to *Sylvius*'s and *Kerkering*'s Opinion, this Juice cauſes an Effervеſcence in the Blood of the Heart. *Petrucci* was of Opinion, that it ſtimulates the Bladder, and by this means cauſes the Secretion of the Urine. *Thomas Bartholin* affirms, that their Uſe is to colour the Urine.

Molinet advanced an Opinion that appears at firſt more probable than all we have already mention'd; he believes that the *Fœtus* makes little or no Water; it is not neceſſary, according to his Opinion, ſince the Blood of the Mother is depurated. But in order that no Secretion can be made in the Kidneys, the Courſe of the Blood muſt have been diſturbed, and a Receptacle muſt have been given it, before it arrived at the Kidney: the *Capſulæ* form that Receptacle; therefore it is that they are as big as the Kidneys in a *Fœtus*.

This Opinion has its Difficulties. 1*ſt*, It is certain that the *Capſulæ Atrabilariæ* muſt not be look'd upon as a ſimple Receptacle; there had been no Occaſion for their wonderful Structure on this Account. 2*dly*, It is certain that there is ſome Secretion perform'd in them; we found a Fluid of a yellowiſh Colour that returns into the Veins: beſides, had not this Fluid been found, its Structure, reſembling that of the *Viſcera* deſtin'd for Secretion, would induce us to judge that there is ſome Matter there ſecreted. *3dly*, This Opinion ſuppoſes that the *Fœtus* makes no Water; but this cannot be affirm'd, till after *Bidloo*'s Opinion has been diſprov'd. This Author has demonſtrated a long while ago the *Tunica Allantoides* in the Human *Fœtus*. *Hornius* and *Graaf* have made the ſame Obſervation. *4thly*, We cannot conceive how ſuch ſmall Arteries could interrupt ſo great a Quantity of Blood. *Bergerus* makes this Objection; as for the other Proof that he brings againſt *Molinet* concerning the Defect of the *Anaſtamoſes* betwixt the Veſſels of the Mother and the *Fœtus*, we ſhall ſpeak of them hereafter.

The Lymphatics that enter and paſs thro' the *Capſulæ*, gave Riſe to Opinions of their ſerving as Strainers to the Lymph: in all this there is nothing as yet demonſtrated.

In order to find out the Uſe of the *Capſulæ*, it muſt be looked after in a *Fœtus*; they are very large as the other Organs that have no Uſe in Adults. All the Opinions contrary to this will be doubtful. We may by that judge of *Boerhaave*'s Opinion, who believes that theſe glandular Bodies are form'd to return the Blood (that comes from the Kidneys) the Lymph it has loſt.

REMARK XXI. *Of the Ureters.*

THE Ureters are between the Duplicature of the *Peritonæum* that covers them with a lacteal Membrane: after this Membrane, the cellular Subſtance and *Rete* appear; this Subſtance or cellular Membrane doth not cloſely join the *Laminæ* of the *Peritonæum* with a proper Membrane;

it floats: after this floating Tunic, there appears the proper Membrane compoſed of three; the firſt is fibrous, the ſecond nervous, and the third villous, which hinders the Acrimony of the Urine from irritating the nervous Fibres. Theſe two Canals that are of unequal Largeneſs in their Courſe, being arrived at the Bladder, pierce the external *Laminæ* towards the poſterior and lateral Part, at two Fingers diſtant from one another, and from the Neck of the Bladder, thus run between this Tunic and the other Membranes, five or ſix Lines; at laſt they obliquely enter the Cavity of the Bladder. This Mechaniſm hinders any Reflux from the Bladder in thoſe Canals; for when the Urine preſſes the Sides, the two Extremities of the Tubes that are between the *Laminæ* are obſtructed: it ſeems that this would ſuffice; but Nature added to this Mechaniſm a Sphincter, which is found in the Bladder at the Extremities of the Ureters: This Sphincter being preſſed by the Urine, obſtructs the Canal, and hinders any Reflux. When the Bladder is fill'd only as high as the Inſertion of the Ureters, the Urine can be diſcharged Drop by Drop; but when the Urine is higher, the Column that is in the Ureters muſt be higher: Thus it may be able to overcome the Reſiſtance that is in the Bladder. This is prov'd by the Laws of Hydroſtatics. At laſt, when the Bladder is fill'd, the Ureters can fill alſo; and hence it is, that often when we have made Urine, we muſt do it again the Moment after; becauſe that which was in the Ureters is diſcharged, and irritates the Bladder.

REMARK XXII. *Of the Bladder.*

THE Bladder is a muſcular and membranous Bag, ſituated behind the *Os Pubis*; its Figure is, as we have already ſaid, like a Pear, whoſe largeſt Part is turned upwards; when it is inflated it is elevated poſteriorly and ſuperiorly: the external *Lamina* of the *Peritonæum*, that lines all the *Abdomen*, adheres pretty cloſe to the poſterior Sides of the *Os Pubis*; behind that Place, where this *Lamina* is inſerted, the Bladder is ſituated: it is united to the external *Lamina*, anteriorly, againſt the *Oſſa Pubis*; its poſterior and lateral Part is alſo covered by the internal *Lamina* of *the Peritonæum*, which adheres to it by a vaſt Number of Filaments. This internal *Lamina*, which covers the Bladder, forms a Band on each Side; it is fixed, or terminates, towards the Border of the ſmall Baſon, and forms that which we call the Ligaments of the Bladder. There are other Ligaments to be ſeen poſteriorly, that are join'd to the *Rectum*; on each Side, after this Membrane, there appears, as we have already aſſerted, a Membrane containing Fat, that is filtrated in its Cellules. Afterwards we ſee the muſcular Membrane, compoſed of longitudinal and tranſverſal Fibres; the longitudinal are the external; they ariſe from the Bottom towards the Neck; the Tranſverſals croſs the firſt at the Neck of the Bladder: then appear the Fibres, that form a ſort of Sphincter: As for the reſt, as the Fibres deſcend obliquely on each Side from the Bottom towards the Neck, they croſs one another in divers Places. After the muſcular Fibres is ſeen the *Tunica Nervoſa*, which is follow'd by a *Villoſa*, where there is a mucilaginous Subſtance filtrated in the glandular Bodies. The Veſſels that are inſinuated in thoſe

Membranes are there ſpread, and form Ramifications different from thoſe ſeen in the other *Viſcera:* We may thereupon conſult *Ruyſch.*

When the Urine has been ſome time retained in the Bladder, it diſſolves the mucilaginous Matter, and irritates the Fibres: after this Irritation, Nature ſeeks to be diſcharged. The Muſcles of the *Abdomen* and the Diaphragm preſs the Bladder; by this Preſſure the Urine compreſſed overcomes the Reſiſtance of the tranſverſal Fibres that embrace the Neck of the Bladder. When this Action ceaſes, the Fibres that form the Sphincter, not being preſſed any more, are re-eſtabliſhed by their Contraction in their former State. There are Muſcles that embrace the *Urethra*, and by their Action propel the Urine that is lodged there. Theſe Muſcles having loſt their Action in old People, we ſee that the Urine that remained at the Bottom of the *Urethra* muſt drop ſome time after they made Water. We will hereafter give the Deſcription of the Muſcles.

Before we explain the Nature of Urine, we muſt look into the different Forms under which this Fluid makes its Exit; it varies according to the Aliments we take, and according to the Paſſions and Times: when we drink much it reſembles Water, it is depriv'd of Taſte and Smell, and can eaſily be retain'd; but when we have eat, and the Chyle is ſeparated from the Aliments, it is colour'd, and in leſſer Quantity, and has ſome Smell; it is not ſo eaſily retain'd, becauſe it irritates the Sides of the Bladder by its Acrimony. When the Chyle is changed into Blood, it is redder, and is not in ſo great a Quantity; its Acrimony augments and irritates more the Fibres of the Bladder: laſtly, when by Abſtinence the Blood is not renewed, the Fluids are heated in the Body, the Urine is not ſo clear as thoſe we have ſpoken of; it alkaliſes ſooner, and conſequently is more acrimonious, and more diſpoſed to putrify, and is leſs in Quantity. Theſe are the Subſtances the Urine is compoſed of: 1*ſt*, There is a real Water. 2*dly*, An acrimonious Salt, very ſubtile and volatile, like an Alkaly. 3*dly*, A very volatile Oil, which is diſpoſed to putrefy. 4*thly*, A *Caput Mortuum*, that has been very much attenuated by theſe Subſtances, and the Motion of the Circulation.

The Water of the Urine is inſipid, we may be convinced of this in letting it evaporate; we obſerve no Smell nor Taſte, yet there remains there a very ſubtile Part of the fetid Oil that cannot be ſeparated from it: this is the Reaſon why the Water rather deſerves to be called Spirit than Phlegm.

The Salt of the Urine is neither Acid nor Alkaly, it is an acrimonious ammoniacal Salt; if there is any *Sal Fixum* found, it is Sea-Salt which is made uſe of in Aliments, and changes not its Form, except in the Human Body, while the more fixed Salts are entirely changed. The Oil of the Urine is but a Part of the Fat that has been ſubtilized; it is very different from all other Oils.

The *Caput Mortuum* is mixed in theſe Subſtances we were ſpeaking of; when it is ſeparated, it is inſipid, fixed, and white.

The Mixture of theſe Subſtances compoſe different Sorts of Urine, according to their different Proportions; theſe are the Qualities with which it ſhould be endowed when the Body is in a State of Health; the Colour muſt be of a Citron; in thoſe who have a Fever it is reddiſh, or of a very deep Colour; in hypochondriacal People, and Women ſubject to the Vapours, it is white. The Smell, according to *Tecmeyer*, muſt be like that of Violets; but if it were ſo, we ſhould but very ſeldom find natural Urine. *Bellini* had more Reaſon to ſay, that it ſhould have almoſt no Smell at all. The

Smell really cannot proceed but from the Salts that tend to be alkalized, and from the Oils tending more to a Putrefaction. All this is contrary to the natural State of Fluids in the Body. As for the Sound of the Urine, when it falls into the Urinal, it muſt be like that of common Water.

In order to have a thorough Knowledge of all that concerns the Urine, we muſt examine from whence ariſes its Colour. When the Phlegm is evaporated, *1ſt*, It becomes yellower, *2dly*, It appears redder, *3dly*, Blackiſh. In changing one Colour to another, it takes a deeper, and becomes always thicker and more ſaltiſh. At laſt there remains a viſcous Subſtance, that in the Bottom of the Pot ſeems to be of a pretty dark Colour; but if we rub with it the Surface of the Pot, it gives it a fine yellow Colour.

The Urine being thus evaporated, we may pour Water upon it: according to the Quantity of the Water pour'd upon it, the Urine will have the ſame Colours we juſt now were ſpeaking of; it will be the ſame as before its Evaporation; it will have the ſame Smell, ſame Taſte; it will putrify, thicken, and precipitate a ſort of Tartar.

According to this Experiment the Urine is more or leſs colour'd, or more or leſs ſaltiſh, according to its greater or leſs Quantity of Phlegm; by which we ſhall be able to give an Account why the Urine is of a different Colour in different Ages, Climates, Paſſions; and why the Urine of thoſe who are of an hot Conſtitution is colour'd. *1ſt*, Becauſe there is a great Evaporation made of the aqueous Subſtance by Tranſpiration; therefore there muſt be leſs Phlegm in that which is filtrated by the Kidneys. *2dly*, As the Blood is more agitated in its Veſſels, the oily Matter being more divided, will paſs eaſier; the contrary of which happens in old People: By only applying theſe two Reaſons to other Cauſes that vary the Urine, it will appear that in hot Climates and violent Paſſions, as in Anger, the Urine muſt be very much coloured.

There are three things to be obſerved in the Urine. 1*ſt*, A Sediment or Matter that is precipitated at the Bottom of the Veſſel. 2*dly*, A Subſtance that is ſuſpended in the Urine and goes by the Name of *Anæorema.* 3*dly*, A Subſtance that is like a Cloud, the Sediment is nothing elſe but an earthy Subſtance with the Salt of Urine; when there is a Motion in the Subſtance of the Urine, or rather whilſt the Heat rarifies the groſs Parts, theſe Matters are there ſuſpended; but when the Cold brings them to a leſſer Bulk they are precipitated; when theſe Subſtances have been very much rarefied then they are ſuſtained in the Urine, and form that which we call in Latin *Suſpenſiones*, the Clouds are nothing but the ſame Subſtance, rarefied in ſuch a manner that they occupy the ſuperior part of the Urine; theſe Principles ſuffice to make us judge of all the reſt.

We may have room here to aſk three or four Queſtions. 1*ſt*, Whether the Urine comes from the Blood. 2*dly*, Whether it is equal to or above the Quantity of the Liquor which we drink. 3*dly*, Whether we may judge of Maladies by Urine. In order to void by the Subſtances that circulate with the Blood, they muſt paſs from the Inteſtines into the lacteal Veſſels, from thence into the Receptaculum Chyli, and at laſt into the Veins, Heart, Kidneys, and Bladder. We have already demonſtrated that there is no other way, ſo that the Urine comes from the Blood. By this means we may explain, 1*ſt*, Why when we have been agitated by violent Motions we void Blood although there is no Stone in the Kidneys, the

Blood being violently propell'd dilates the ſecretory Canals, and paſſes through the Urine. 2*dly*, It appears alſo by this, why Heat, Motion, Sweat, and Abſtinence make the Urine red, acrimonious, ſaltiſh, and nauſeous; the Blood loſes then its aqueous Parts, the Heat which is produced by the Motion diſentangles the Salts, and attenuates the Oil, it muſt then depoſit in the Kidneys a colour'd Fluid, more ſaltiſh and more fœtid than the Blood itſelf, becauſe in the Veſſels it is mixed with more viſcous Subſtances and more heated than in its Ducts. 3*dly*, We may explain why the Chyle that is more ſubtile than other Fluids is not diſcharged; the Reaſon of which is becauſe it thickens in the Lungs in paſſing from the capillary Veſſels through the biliary Ducts; the renal Tubes are ſuch that nothing which is as bulky as the Blood, Chyle, or Ceroſity, can flow there.

There are ſome Phyſicians who were of Opinion that the Urine was more in Quantity than the Liquor that we drank; but this is inconſiſtent. All the Aliments that we uſe are filled with Juice; thus Urine may ſurpaſs in Quantity the Liquor we drink, nevertheleſs according to Tranſpiration, other Evacuations and Diſeaſes, the Quantity of Urine diminiſhes or encreaſes. Some Quacks pretend to know Diſeaſes by the Inſpection of Urine only; but this is impoſſible. 1*ſt*, In order to do this, it is neceſſary that every Diſeaſe, according to the Part affected, ſhould impreſs a particular Character on the Urine, which is impoſſible. 2*dly*, They muſt alſo exactly know the natural State of Urine in every Subject, becauſe there are Perſons whoſe Urine is like that of ſick People, when they even enjoy a perfect State of Health. 3*dly*, The Air alters the Urine a little while after it has been diſcharged from the Bladder.

der. *4thly*, The venal Tubes are ſometimes very much dilated; this Dilatation makes great Alterations in the Urine, although the Perſons are very well. *5thly*, The State of the Blood cannot be known by Urine, becauſe the Heat, Age, Aliments and Paſſion change it from time to time; *a fortiori*, we ſhall not be able to judge of the Diſtempers, that attack the Solids by it; and yet in malignant Fevers the Pulſe and Urine will appear as good as in thoſe who enjoy a perfect State of Health.

The Urine forms Stones in the Bladder and Kidneys; they have recourſe to diverſe Hypotheſes to explain this Phænomenon; ſome have had recourſe to a petrified Fluid, others to chymical Mixtures. There are ſome who have aſſerted that the Stone is formed in the ſame manner as theſe ſtony Incruſtations which are found in Veſſels where there has been Water a long while a boiling, or in the ſame manner as the Tartar that ſubſides in Hogſheads. *Fernel* explained the Formation of the Stone beſt; he ſays, there is no Stone formed in the Bladder unleſs there be a Kernel that ſerves for a Baſis; around about this there are Strata of a viſcous Subſtance. There is really obſerved in almoſt all Stones a Subſtance that is in the Strata that ſurround it. *Nuk*'s Experiment made by other Anatomiſts after him confirms this Opinion. This Anatomiſt opened the Bladder of diverſe Dogs; he there put a ſort of a Subſtance like Cloth. Some time after having again opened the Bladder of thoſe Dogs he found that there was a real Stone formed around that Subſtance; this being laid down, if the Blood abounds with terreſtrial Matter, a part of that Matter will remain in the Kidneys or Bladder: If the Bladder is lax, as in Infants, or inflexible as in old People, this Matter will not be expell'd, ſo that the Strata of a viſcous Matter will be formed around it. As for the Sand that is in the Urine 'tis nothing elſe but the terreſtial part very much attenuated, and ſeparated from the Oil; I have ſeen ſometimes whitiſh Concretions that reſembled Mortar, and ſmelled very ſtrongly.

This is almoſt all that may be ſaid of the Urine, and the Strainers through which Nature has made it paſs. The animal Œconomy cannot be deprived of this Secretion without Diſorder; it is true the Canals that ſecrete the Sweat could ſupply it in ſome meaſure; yet when the Urine is cloſed in the ſanguinary Veſſels it cauſes Convulſions, Lethargies and Apoplexies; ſometime the Urine thus gathered is diſſipated through the Pores that ſerve for Tranſpiration. *Salmuth* gives an account of a Man's ſwelling all over his Body after a Stoppage in the Urine cauſed by nephritic Pains, the Sweat diſſipated the Matter which cauſed the Swelling, and facilitated the Exit of the Stone.

REMARK XXIII. *Of the Teſticles.*

THE ſpermatic Arteries deſcend from the Aorta; their Origin is at the anterior part of this Veſſel; this is certain, nevertheleſs the left ſpermatic Artery has been ſometimes obſerved to riſe from the emulgent. Their Bulk, which is not very remarkable, is the Reaſon they do not carry much Blood in them, and their oblique Situation contributes towards it. Theſe Veſſels deſcend obliquely, and join to the ſpermatic Veins that run from the emulgent Vein at the left ſide, and from the Vena Cava at the right; yet it is not always ſo, the ſpermatic Arteries and Veins when they are joined form an acute Angle, and are cloſed in a common Membrane; they are mixed together in that *Involucrum* and run under the internal Lamina of the *Peritonæum* upon the Muſcle, Pſoas and Ureters. When they are arrived at the Groin under the fleſhy Fibres of the tranſverſal Muſcles, the Fibres of the internal Oblique make way for their Paſſage; the Place where they paſs under the tranſverſal is higher than that where they pierce the internal oblique Muſcle; at laſt the oval Ring found in the tendinous part of the oblique Muſcle which receives all theſe Veſſels, is three Lines lower than the other Paſſages. Before the Veſſels pierce the Muſcles, the external Lamina of the *Peritonæum* is extended in length, and forms a Bag which the Veſſels penetrate. This Bag paſſes over the Os Pubis and Muſcle Pectineus; being come to the Scrotum ſuſtains the Teſticles in its Bottom. When the Extenſion of the *Peritonæum* makes its way from the Abdomen, it is received by a Muſcle called *Cremaſter* or *Suſpenſor*; this Muſcle takes its riſe by a fleſhy Origin from the anterior inferior part of the Spine of the Bones of the Loins; they are fixed when they deſcend to the Borders of theſe Bones, and to the tranſverſal Muſcle; then it embraces the Tunica Vaginalis, and by extending forms a Tube that ends where the *Involucrum* begins to enlarge, and is there diſtributed all around; this Muſcle elevates, compreſſes and ſuſtains the Tunica Vaginalis. Theſe are not the only Coats in which the Teſticles with the *Involucrum* are encloſed: The Epidermis without with the Skin forms a common Bag; in the Middle we remark a Seam; under that Bag there is another that is muſcular, but it is not as common as that we have been ſpeaking of. There are two little Bags joined to one another; their Conjunctions make a double muſcular Plan that forms a Partition to ſeparate the Teſticles. Theſe two muſcular Bags riſe upon the *Tunica Vaginalis*, whic they embrace; they are extended even upon th *Cremaſter*; they adhere to a Ligament that embraces the Penis; it is this Muſcle that wrinkle the external Bag. In the internal part of tha Bag are the Teſticles environ'd by a proper Membrane, and is ſtreightly united to their Subſtance: it is called the Tunica Albuginea. In the Subſtance of the Teſticles are obſerved Rays that reſemble thoſe we ſee in Oranges; there are alſo tranſverſe Fibres in thoſe Rays, the ſame as in thoſe of Oranges. Before we go any further, let us view again the ſpermatic Veſſels, as they enter thoſe Bags and Subſtance of the Teſticle.

The ſpermatic Arteries form in their way Lines almoſt ſpiral; they ſend out Branches, that according to *Leal Lealis* are inoſculated with the lateral Veins; but this is falſe. Theſe Arteries when they approach the Teſticle, emit a Branch that diſtributes Ramifications to the inferior and interior part of the Epidermis, and is afterwards inſerted in the *Tunica Nervoſa* or *Albuginea*; ſometimes they ſend forth a Branch to the ſuperior part of the Teſticle, but we conſtantly find a very large one inſerted on the ſuperior part of the Epididymis, and ſends forth Ramifications on every ſide; at the ſame time many Ramifications, mixed with the Veins in the pyramidal Body, are diſtributed around the Teſticles. There are Veins that anſwer theſe Arteries and carry back the Blood; the pyramidal or pampiniformal Body receives from the back of the Teſticle an infinite Number of ſmall venal Canals: Theſe Ramifications aſſembled together in the Form of a Net communicate the one with the other, and laſtly form a large Trunk which is the ſeminal Vein.

Theſe are the Arteries and Veins as they appear out of the Teſticle; let us examine how the

Arteries penetrate the Windings and Turnings of the Subſtance. They are divided into an infinite Number of Branches when they have penetrated the *Tunica Albuginea*, and terminate in ſecretory Veſſels that carry their Fluid in the middle, for which reaſon they have no Veins; theſe ſecretory Veſſels open in a longitudinal Canal, called the *Corpus Highmori*, which is in the middle of the Teſticle. All theſe Tubes at laſt concur to form the Epididymis, which is a cylindric Canal ſituated upon the Body of the Teſticle, and bent by many Pleats. As ſoon as it has left the Teſticle it is called the *Vas Deferens*; it riſes above the *Os Pubis*, enters the Baſon, and is thrown into the *Veſiculæ Seminales*.

There are Nerves that concur to form the Structure of the Teſticle; there are ſome that accompany the ſpermatic Veſſels and diſappear in the *Tunica Nervoſa* or *Albuginea*; there are others of which in Neurography; there are likewiſe in the Teſticles many Lymphatics that carry back the Lymph.

In theſe wonderful Organs is formed that precious Fluid that has been the occaſion of the Multiplication of Mankind throughout ſo many Ages; the Preſſure of the Coats, the elaſtic Force of the Fibres, and the Pulſation of the arterial Veſſels propel it through the Canals we have been ſpeaking of: This Fluid takes a long Courſe. The Epididymis in a Rat are of a vaſt Bulk, when they are unfolded. *Bellini* found out by his Calculation, that if the Veſſels compoſing the Teſticle of a Man were unfolded, they would be more than three hundred Ells long, but I do not believe that all the Body of the Teſticle is compoſed of one Veſſel only, of which the Epididymis is a Production. The Structure which we have already mentioned ſeems not to agree with this Opinion; its Capſulæ, Veſſels that go out of it that terminate in the *Corpus Highmori* give no room to think that it is but one Veſſel that forms many Circumvolutions; as for the Epididymis it is very long, when drawn out in a right Line.

How doth this Seed which is filtrated contribute to form Men? Is it an occaſional Cauſe by which the *Supreme Being* is determined to form the Embrio? Is it a Subſtance which Ideas are encloſed in? or plaſtic Natures that give it different Configurations? Is it a ſimple Liquor that contains *Animalculæ* entirely formed, and that are only unfolded? All theſe Opinions, though chimerical, have had their Aſſertors.

If it be allow'd to ſay ſomething in ſo great an Obſcurity, the firſt Opinion I believe cannot be defended: if God ſought but an occaſional Cauſe, was it neceſſary to make ſo great an *Apparatus* for a Fluid? It is true this Difficulty is eaſily anſwer'd. It may be alledged that this *Apparatus* is only to give a Perfection to the Seed, of which it had need afterwards to produce certain Effects in the Body, that are particular to Men. What we may here ſay is, that perhaps it may be ſo; but it is not probable: the firſt View that the Author of Nature ſeems to have propos'd in forming theſe ſeminary Canals, is the Generation of Man.

The ſecond Opinion has been defended by many Philoſophers; there are *Phænomena* that ſeem to prove plaſtic Natures diſperſed in the Matter to give it divers Configurations; the Plants partake of it; when one Branch is cut there ariſes another: But what proves the Exiſtence of plaſtic Natures moſt in Animals, is the Craw-fiſh; if one of its Claws is cut, another is produced in its ſtead, as the Branches of Trees: Let a Joint be cut, or that which is above it, it all appears again in the ſame Order. Theſe are wonderful Productions. That which is under a Joint is ſeparated from that which is above, and is only united to it by Ligaments; it doth not ſeem that the one is a Production of the other: beſides, there are Muſcles inſerted from the two Extremities, in Parts that are under the Inciſure. We cannot ſay that this is only an unfolding; many Parts cannot be reputed the ſame before the unfolding, in the ſame Manner and in the ſame Part; but it ſhould be in this manner if there were an unfolding; if the new Claw that grows again in the Crawfiſh ariſes from the ſame Part, and performs the ſame Functions.

The third Opinion cannot ſubſiſt, if the firſt is true, unleſs they will affirm that the plaſtic Nature forms even in the Seed, the Rudiments of the Embrio; but we cannot ſay that thoſe *Animalculæ* diſcovered in the Seed, can be in Men in Miniature. 1*ſt*, It is certain there are *Animalculæ* found in all the Fluids of the Human Body. 2*dly*, In the Seed of a Woman they are diſcover'd as well as in Men. 3*dly*, Suppoſing all this not to be ſo, there could be no ſufficient Reaſons given to conclude that it is ſo; for when the Parts of theſe Animals were to be extended, the Progreſs of the unfolding would not be as thoſe which we ſhall take notice of in the Embrio, where there is nothing leſs obſerv'd than an Animal entirely form'd. This Opinion was at firſt receiv'd. 1*ſt*, There have been *Animalculæ* diſcover'd moving in the Seed. 2*dly*, *Leeuwenhoek* has extended his Diſcoveries thro' a Microſcope ſo far, that he pretends to have diſtinguiſhed the Sexes in theſe *Animalculæ*. 3*dly*, It has been obſerv'd, that they are not found in thoſe that are much addicted to Venery. This agrees with Experience, which teaches us, that thoſe who are given to Women are barren. 4*thly*, It has been obſerv'd, that the

Animalculæ that are in the Seed of young Peopl are vigorous, and thoſe of old People die immediately: this may be the Reaſon why old Peopl are not prolific. Several Hypotheſes have bee built on this Foundation. Some were of Opinion that the Seed being injected in the *Uterus*, on ſmall Worm eat the other, and that the laſt, whic was nouriſhed by all the others, form'd the *Fœtus* Others believ'd, 1*ſt*, That theſe ſmall Worms entered the *Ovaria* thro' the Fallopian Tubes. 2*dly*, Being arriv'd at the *Ovaria*, they crawl'd upon the *Ovum* that was ripe. 3*dly*, That the firſt which met with the Hole that was in the *Ovum*, enter'd into it. 4*thly*, That there was a Valve hindring its Return. 5*thly*, That were there many *Ova* ripe, many *Fœtus* would be form'd, becauſe many Worms were introduced into theſe *Ova*.

It is plain that this Deſcription is produced by the Heat of Imagination: there are many other Reaſons beſides this which I have alledged, to prove how this Opinion is ill grounded; but one of the principal Reaſons that overthrow it, is the begetting of Monſters: For, 1*ſt*, It is certain that Animals ſprung from two different Species partake of both Species; ſome have the Head of one Species and the Body of another; others have the Feet of one and the Jaw-Bone of another, *&c.* In order that this may agree with the Syſtem of the *Animalculæ*, theſe Monſters ſhould be form'd in theſe *Animalculæ* that are diſperſed in the Seed, but it is in our Power to couple Animals of different Species; every time they copulate they will engender Animals of two different Kinds. Would it be poſſible that little Monſters ſhould be inſtantly found in all theſe Copulations? Beſides, it cannot be denied that the Ideas do not always modify Matter; the Marks that appear in Infants, whoſe Mothers have Longings, the odd Figures with which the *Fœtus* has been marked, according to the Imaginations of its Mother, all this proves the Action of the Ideas. If this is aſſured to be ſo, the Opinion that imputes the Generation of Man to the *Animalculæ*, cannot eaſily ſubſiſt; for according to the Objects ſtriking the Imaginations, there are found in the *Fœtus* Parts organiz'd, whoſe Rudiments were not in the *Animalculæ*. This being granted, we may more likely conclude for the Exiſtence of plaſtic Natures. But 'tis better to be ſilent in ſo great an Obſcurity.

REMARK XXIV. *Of the* Epidydimæ.

I Have already in ſome meaſure given the Deſcription of the *Epidydimæ*; there is nothing to be added to what I have already ſaid: I ſhall only take notice of the Uſe that they ſeem to have. The Blood brought to the Teſticles is depriv'd of its moſt ſubtile Part; that after having paſt thro' all the Windings and Turnings in the Teſticles, enter the *Corpus Highmori*; from thence it is carried into the *Epidydimæ*, where it is brought to a greater Perfection: in all this Courſe it perhaps receives a new Fluid of the Nerves. Howſoever it be, it is certain that the Seed is not in the Blood, ſuch as we ſee it when it is ejected from its Receptacles: for, 1*ſt*, Children when they begin to have Seed, grow more vigorous. 2*dly*, Eunuchs are much weaker than thoſe who have been diſmember'd. It neceſſarily follows then, 1*ſt*, That the Seed, after being filtrated in the Teſticles, re-enters the Maſs of Blood, and carries the Fluid that ſtrengthens the Parts along with it. 2*dly*, That there muſt be ſomething in that Seed which was not there before, otherwiſe it would cauſe the ſame Effects in Eunuchs as in thoſe who are not diſmembred. But we can ſay nothing of the Veſſels that abſorb the Seed, that it may return

turn in the Blood. Some believ'd that it was Lymphatics that met the Seed in its Courſe, for example in the *Epidydimæ:* others were of Opinion, that the Seed re-enter'd the Blood from the *Veſiculæ Seminales*; but that is nothing but an Hypotheſis.

REMARK XXV. *Of the* Vaſa Deferentia.

THE *Vaſa Deferentia* have many Windings and Turnings in their Beginning. Theſe Circumvolutions cauſe the Veſſels in ſome meaſure to reſemble Silk-Worms by their Foldings, and are the Cauſe why their Canal is not entirely cylindrical; for the Sides preſs againſt one another, by Reaſon of the Foldings that are ſtrengthen'd by Filaments deriv'd from a Membrane. The Canal is compoſed of a pretty hard Cartilage; this was neceſſary for the Courſe of the Seed: the internal Surface is as it were ſpongeous. At the Side of theſe Canals there appear an infinite Number of Veſſels there inſerted, perhaps they are changed into lymphatic Arteries at the cartilaginous Part. In proportion as theſe Tubes approach the Veſicles, they form Anfractuoſities, and join to the Neck of the Bladder, like two Segments of a Circle. The *Veſiculæ Seminales* are at the Sides of theſe Segments; and in the Inſertion of their Extremities and *Veſiculæ Seminales* there is a Valve hindering the Return of the Seed. By this Deſcription of all theſe Veſſels, it appears that there is not a Fluid prepar'd with a greater *Apparatus*, or ſlower than the Seed:

Tantæ molis erat mortalem condere gentem.

REMARK XXVI. *Of the* Veſiculæ Seminales.

THE firſt thing that occurs in the *Veſiculæ*, is the internal Membrane of the *Peritonæum* that covers them: under this Membrane there appears a muſcular one. *Leal* has given a fine Deſcription of them, when he ſaid that they were ſmall *Cæca* in divers Windings and Turnings. When we blow thro' the *Vaſa Deferentia*, the Air paſſes into the *Veſiculæ* and *Urethra*. The Opening of the *Veſiculæ* in the *Urethra* is ſuch, that it hinders the Return of the Seed. The *Veſiculæ* in the Approach of the Male and Female are emptied. The Convulſions all the Muſcles that environ the Bladder undergo, expreſs the Content of theſe little Bags. Hence it happens, that there ſometimes is Seed voided with the Stool. The Explanation of this is not difficult; the Excrements that puff up the Part of the *Rectum* that is under the Veſicles behind, preſs the *Veſiculæ*, and occaſion the Exit of the Contents.

REMARK XXVII. *Of the* Proſtatæ.

THE *Proſtatæ* have the Shape of a flat Heart, ſurrounded by muſcular Fibres, and that in the Place where it is flat encloſe the Neck of the Bladder; the Baſis is poſterior, and the Apex anterior. At the internal Part of the *Urethra* towards the middle, there is a long Eminence, upon which there are *Foramina* that come from the *Veſiculæ Seminales*. At the Side there are Overtures or Orifices of the Tubes, that come from the Cells of the *Proſtatæ*. There are twelve *Capſulæ* ſeparated from the Glands; every Gland of that *Capſula* has a Duct that carries the Matter it receives in the Strainers into a ſmall Bag: there are twelve of theſe Bags diſcharged at the Side of this longitudinal Eminence that is in the *Urethra*; ſo that the Seed and the Liquid that comes from the *Proſtatæ* can mix perfectly. When the Muſcles of the *Abdomen* preſs the Contents of the Baſon in the Stools, there iſſues out but a little of it; nor doth it contain *Animalculæ* as the Seed, as is pretended. After the Teſticles are taken away, and the ſeminal Veſicles have no more Action, it ſubſiſts, but is not proper for Generation: hence it appears that it only ſerves to dilate the Seed, and to nouriſh (as a great many Authors would have it) the *Animalculæ* that are in the Seed. Theſe are all the Reſervoirs that contain the Seed or its Vehicle.

REMARK XXVIII. *Of the Penis.*

THE Corpora Cavernoſa are the principal part of the Penis; after they are come from the inferior part of the Os Pubis they are covered by a tendinous Membrane; they join at acute Angles and adhere to one another; by their Adherance they form a Partition that diſappears at the anterior Part. Theſe two Bodies are ſurrounded by a cellular Membrane, covering even the Septum, inſinuating themſelves between the two Corpora Cavernoſa. There then appears a pretty hard Membrane that is under the Cutis and Epidermis. There are commonly Arteries ariſing from the internal Iliacs to carry the Blood in the Corpora Cavernoſa; it is thought that the Blood in the other parts of the Body is received again by Veins that are Continuations of Arteries, but here the Blood manifeſtly is expanded in all the cellular Bodies; it is afterwards received by the great Vein that is upon the back of the

Membrum virile; this Vein is divided into two towards the Proſtatæ, and is diſcharged on each ſide in the internal Iliacs.

It is paſt all doubt that the *Corpora Cavernoſa* are inflated by the Blood; this Inflation cannot happen unleſs the Veins, being compreſs'd, permit nothing to paſs; we muſt therefore ſeek for a Cauſe that ſtops the Blood, and here follows what is commonly ſaid thereupon.

The Erectores come from the Tuberoſity that is at the *Os Iſchion*; they are ſituated under the Origin of the *Corpora Cavernoſa*, and are inſerted at the tendinous Membrane of the ſame Body; it muſt then neceſſarily happen that if theſe Muſcles are inflated they will compreſs the Corpora Cavernoſa at its Origin againſt the Os Iſchion, than the Veſſels that are compreſs'd won't permit the Blood to flow; at the ſame time the Body of the Penis will be ſtronger applied againſt the Os Pubis and Ligaments, and the great Vein compreſs'd by this Preſſure will ſtop the Courſe of the Blood. Hence it appears that the Arteries, Veins, *Corpora Cavernoſa*, and the ſpongeous Texture of the Urethra muſt be inflated, the nervous Papillæ at the Head of the Gland are then more extended, the Frictions of the Papillæ againſt the ſides of the Vagina will cauſe frequent Vibrations in the Nerves. During this time the Cauſes that inflate the Penis act ſtronger, the Redneſs and Stiffneſs of the Parts inflated muſt then augment, the muſcular Membrane of the Proſtatæ and *Veſiculæ Seminales* is ſtretched. By the ſame Cauſes this Tenſion makes the Seed flow in the part of the Urethra that is not compreſs'd by the Erectores; the tranſverſe Muſcles are diſpoſed in ſuch a manner as to draw the Urethra in dilating the Cavity; this Dilatation gives place to the

Seed to gather there. The *Muſculi Acceleratores* ſprung from the Concourſe of the tranſverſe Muſcles, diſtributed on the *Bulbus*, inſerted in the cavernous Bodies, ſtretch and compreſs the Place to which they are fixed; the Muſcles of the Proſtatæ and of the Veſicles enter alſo in Convulſions. By theſe Motions the Blood is puſhed with Violence in the *Membrum Virile*, the Gland is inflated, the ſpongeous Body of the Urethra ſtiffens, and ſuffers a great Irritation to the nervous Papillæ of the Glands; from thence there follows a great Convulſion that drives out the Seed with great Violence; then is the Urethra emptied, the Blood which is in the ſpongy Body is leſs preſs'd. In the Concourſe of Muſcles it can then retake its Courſe, hence the Penis becomes flabby as before; as the Nerves depoſit ſome Liquor in theſe Convulſions they become as paralytick, becauſe they are no more animated by that Spirit that extends them; there will then be a kind of Palſy, that will in all the Body cauſe a kind of *Languor*.

This is what may be ſaid upon the Erection with a great deal of Probability, but we muſt confeſs that it will not bear an accurate Examination. 1*ſt*, The Muſcles called *Erectores* are diſpoſed in ſuch a manner that they ſeem not able to compreſs the Corpora Cavernoſa ſo as to ſtop the Blood; the Inſpection of theſe Parts will prove it better than the Reaſonings we can make uſe of. 2*dly*, The tranſverſal Muſcles pull the Urethra downwards, for the part of the Bone in which they are inſerted is lower than the part of the Urethra where they are joined; they can draw the ſpongeous Contexture of the Urethra, but cannot dilate the Cavity, then the Blood only enters this ſpongeous Contexture in a great Quantity,

tity. There are many other Difficulties that I ſhall not here mention, they will be perfectly known if we take Pains to examine the Parts.

Notwithſtanding the Difficulties juſt now mentioned, it is undeniable that the Muſcles already taken notice of in explaining the Erection are agitated by convulſive Motions *in Coitu*. Hence it appears that in Lithotomy where theſe Muſcles are wounded, there may happen a Priapiſm.

If it happened that by the great Irritation cauſed in the Nerves that are extended throughout all the Muſcles, the Motion would there continue a long while, there would neceſſarily enſue a Priapiſm. This is proved by thoſe who have uſed Venery to exceſs; as there were violent Motions in their Parts attended with a very great Heat, the Inflammation that follows irritates the Nerves, that by their Motion extend the Muſcles and cauſe a Priapiſm.

The Ejaculation of the *Semen* is ſtronger according as the Ejaculations act with greater or leſs Force, but this Force is proportioned to the Quantity of Seed, the more of it there is the more are the Nerves extended. Beſides, when the Seed is in greater Quantity it inflates more the poſterior part of the Urethra, where it is gathered before its Emiſſion, conſequently the Muſcles act with greater Force; for 1*ſt*, they are preſſed more; 2*dly*, in proportion as the part of the Urethra is inflated the Semen has a more rapid Courſe in the reſt of the Canal. Hydraulicks teach us that when a Fluid paſſes from a large Canal to a narrower, the Velocity is proportioned to the Smallneſs of the narrow Canal; 3*dly*, in the ſame manner as a Muſcle fixed under a Tuberoſity draws that Bone ſtronger whoſe Tuberoſity is very big; the Ejaculatories act ſtronger when there is a great deal of *Semen* gathered, and

when

when there is a large Maſs formed in the Urethra.

Fear produces the ſame Effects as Weakneſs; when the Mind is ſeized by that Paſſion it is felt throughout the whole Body, but its Impreſſions do not appear in any Part as much as in the Parts of Generation. We don't know by what Means Fear is felt throughout all the Body, but Experience teaches us that in this Paſſion the Action of the Nerve ceaſes. There is a Philoſopher who is of Opinion that the Soul is that Principal which gives Tenſion to all the Parts of the Body: He aſſerts it to be impoſſible to find out a mechanic Cauſe to explain this rightly. If this Opinion were to be admitted, it might be ſaid that the Soul is retired and in a manner concenter'd by Fear, then it doth not extend the Parts of the Body more, conſequently all muſt be ſhrink'd, the vital Motions can act but with a great deal of Difficulty. In the Caſe concerning the Parts of Generation, or rather the Nerves that are there expanded, are not any more ſo animated; Fear cauſes the Fluids to flow with greater Difficulty, they require ſome time before they regain their former Courſe.

REMARK XXIV. *Of the Womb and Menſtrual Flux.*

IN Women the Os Sacrum is larger and more advanced outwardly than in Men; the Coccyx is not as crooked as before; the Oſſa Innominata are larger, more diſtant from one another, more open below. Hence it is that Women are more bulky than Men about this Bone, and that the Cavity of their Baſon is much more conſiderable; in this Cavity between the Rectum and the Bladder is ſituated the Uterus or Womb.

The internal Lamina of the Peritonæum which is in Men between the Rectum and Bladder is raiſed and inflated; the Womb is ſituated in this Bladder, formed by the internal Lamina of the Peritonæum; it is a triangular Body, a little flat; it has a kind of Ligaments, ſome are called broad. They are the lateral Pleats, formed, as *Heiſter* ſays, by a Lamina of the Peritonæum; from the Concourſe of theſe two Pleats ariſe the round Ligaments which are nothing elſe but a Plexus of Veſſels that paſs through the Rings, and are loſt in the Fat near the Groins. The ſpermatic Arteries of the Ramifications of the Hypogaſtrics, &c. environ all the Womb, and laſtly diſappear after infinite Subdiviſions that form a part of the Womb; Ramifications of the external Iliac are raiſed by the Groins, enter the Baſon, are curved, are applied to the ſides of the Womb, and are inſinuated there in the ſame manner as the others. The Texture of the Womb is ſoft, compoſed of a ſort of Pulp capable of Diſtenſion; there is exteriourly an elaſtic muſcular Membrane, as we have already ſaid; theſe Fibres are diverſly intermingled. Interiourly the Texture of the Womb is covered with a fine Membrane, pierced with many little Holes; when this Viſcus is dilated, it ſeems that the Sides being more extended ſhould diminiſh, notwithſtanding they augment very much; this happens becauſe the Veſſels that are in the ſpongeous *Rete* are extraordinarily inflated. The arterial Veſſels before they change into Veins, form many membranous Ducts that are not very different from thoſe diſcovered in the Breaſts; they are diverſly interwoven and united in many Places; they open laſtly into the Cavity of the Womb by little Holes.

Women are generally ſubject every Month to an Hemorrhage in the Parts of Generation. There been Phyſicians who attributed this Evacuation to the Moon; I will not ſpend any time in confuting this Opinion. Experience which demonſtrates the menſtrual Flux, arriving to certain Women every Fortnight, and to others later, confutes this Opinion.

Others believed that a Ferment was gathered in the Womb, this Ferment at laſt augmenting, and having remained ſome time in the Texture of the Womb is heated and takes fire (if we may ſo term it) then by its Motion it breaks the Veſſels and gives a Paſſage to the Blood. 1*ſt*, We ſhould have a Reaſon to prove the Exiſtence of this Ferment. 2*dly*, We ſhould alſo explain how this may be formed, and in what Receptacles of the Womb the Ferment is gathered. 3*dly*, Why this Ferment is not gathered in any other part of the Body; there has no Reaſon been given upon this Head, but we will in another Place prove that the Blood is incapable of fermenting.

Galen attributed theſe periodical Fluxes of Women to a Plethora. It is ſurprizing that Phyſicians ſhould have ſo little regarded this Opinion; they were for ſeeking a chymical Ferment, while they had a ſimple mechanic Cauſe of the menſtrual Flux plainly demonſtrated: Theſe few Propoſitions muſt be ſuppoſed to eſtabliſh this Opinion.

The Maſs of our Body augments not, if the Matter that iſſues out by Tranſpiration or Evacuations is equal to the Quantity of the Aliments we uſe, and *vice verſa*.

When there is an Evacuation, of Blood for Example, it is evident that if after the Evacuation has ceaſed, the Maſs of the Body is the ſame, as long time before the Blood circulated; it is evident, I ſay, that there is a Plethora. When there happens an Evacuation occaſioned by a

Plethora, the Evacuations made by Tranſpiration, Urine, &c. muſt neceſſarily not have been equal to the Quantity of Aliments that were uſed.

When a Plethora alone is the Cauſe of any Evacuations, that which went off by Tranſpiration, Urine, &c. and by that Evacuation, equals the Quantity of Aliments uſed.

Weakneſs ariſes from the Softneſs of the Fibres; Women are much weaker than Men, their Fibres conſequently, as thoſe of the Heart for Example, muſt be weaker; but if the Fibres of the Heart be weaker, they will not propel the Fluids in the Strainers with the ſame Force, conſequently the Secretions will be leſs.

According to the Demonſtration of *Bellini*, the Secretions are as the Velocity of the Fluids, and the Orifice of the Strainers into which they are propell'd, for by the firſt the Impulſion is leſs ſtrong in the Veſſels of Women, the Blood then *cæteris paribus* muſt run ſlower in Women, and the Strainers be leſs dilated.

According to *Hippocrates* and Experience Women are of a moiſter Conſtitution than Man; and according to *Sanctorius* his Obſervation, moiſt Bodies tranſpire leſs than dry ones, Women therefore tranſpire leſs than Men.

According to *Sanctorius*, the want of Exerciſe hinders their Tranſpiring, Women therefore tranſpire leſs than Men, for they exerciſe leſs; it is true they ſweat more; but *Sanctorius* tells us alſo that Sweat diminiſhes Evacuation occaſioned by Tranſpiration.

Women who work much are ſubject to leſs Fluxes, and thoſe who have not many *Menſtrua* are ſtronger, and have a very ſtrong Pulſe, as *Galen* obſerved. *Sennert* and *Forreſtus* ſay, that Women uſed to dancing and jumping are not ſubject to menſtrual Fluxes as other Women are. By the firſt Propoſition it has been proved that there neceſſarily muſt enſue a Plethora, when the Evacuations equal'd not the Aliments. By the ſecond we have proved that many Obſtacles hindered theſe Evacuations in Women; we may therefore conclude that they will be ſubject to Plethoræ. The Force of a Body put into Motion augments in Proportion as the Velocity or the Maſs encreaſes; we have ſeen that the Maſs augments in the Blood of Women, it therefore follows that the Force is greater; the Blood that beats againſt the Veſſels of the Womb with three or four Degrees of Force, will there beat with four or five during a Plethora; add to this, that when the Blood is more abounding, all the Parts are more contracted, conſequently the Heart will have more Tenſion; if this be ſo, it will propel the Blood with greater Force and Velocity. When a Liquid flows through a ſtrait Canal, the Sides of the Canal are preſſed; this Preſſure depends on the Height of the Fluid, on the Force that propels it, on the Maſs of the Fluid, and on the Figure of the Canal. When the Duct is ſtrait the Sides reſiſt not very much againſt the Motion of the Fluid, but when the Canal is curved, than the Effort made againſt the Sides is much greater; the more the Curvity approaches the right Angle, the greater will be the Force of the Blood that puſhes againſt this Curvity. The Veſſels of the Womb are curv'd and interwoven, the Blood will conſequently beat with more Vehemence againſt their Sides.

The inferior Diviſion of the *Aorta* is much larger proportionably in Women than in Men; the Womb bears the Preſſure of the Blood of the *Aorta*, which is perpendicular, on it: this Preſſure join'd to that already mentioned, will cauſe a great

Diſtenſion in the Veſſels, and will give the Reaſon why Females of almoſt every Animal are not ſubject to the *Menſtrua:* as they walk on all fours, their Womb is delivered from the Heavineſs of the Blood that preſſes that of Women, becauſe of their ſtrait Poſture: hence it is that Female Monkeys have their Menſes.

We may conclude from what we have already ſaid, that the Preſſure being conſiderably augmented in the Womb, the Blood muſt iſſue out of the membranous Ducts we now made mention of; it finds no Reſiſtance in the Air which is in the Cavity of the Womb: therefore when it is propel'd with a little Force, it will dilate theſe ſmall Ducts in the ſame manner as violent Motions of the Body dilate the Ducts of Sweat.

It is objected by ſome, that Women who die of Conſumptions, and are very lean, are ſubject to their Menſes as others: but Subjects that are moſt lean are thoſe who have moſt Blood; fat, when abounding, compreſſes the Veſſels, and hinders them from extending: beſides, in thoſe who die Phthiſic, a great deal of Blood is found in the Veins, as *Charleton* obſerves.

It is objected again, that a Plethora ſuppreſſes the Menſtrua: but hence would be prov'd, that the Plethora of the Bladder is not the Cauſe why the Urine is propel'd with greater Force; for there is a Suppreſſion of Urine when it is too full; the Veſſels being extremely inflated, are preſſed againſt the internal Side of the Womb: by this the ſmall Ducts are ſtopped: Beſides, by the ſame Reaſon that the Inteſtines being too much inflated, are cloſed, the ſmall Ducts that open into the Cavity of the Uterus, in ſhrinking muſt cloſe the Orifice of theſe ſecretory Ducts that open into the Veſſels, dilate immediately: the Parts that follow being pulled, enter that Orifice ; as we may ſee it by Experiments tried in many things.

It is again objected, that the Blood ſhould rather iſſue out thro' the pulmonary Veſſels. No other Anſwer can be given to this Objection, than the different Structure of the Parts : the Blood may flow with greater Eaſe from the Veſſels of the Womb ; 1*ſt*, Thro' the Ducts that are found open in the Cavity, which we ſee not in the Lungs. 2*dly*, The Veſſels are much larger in the Texture of the Womb than in the Lungs. 3*dly*, Reſpiration makes the Blood flow in the pulmonary Veſſels ; but there is nothing to make it flow in the Veſſels of the Womb : but if it happens that the Blood cannot run out thro' the Womb, then it forces its Paſſage thro' the Lungs, or elſewhere, *&c.*

The Plethora is not form'd at once, but gathers by degrees : when the Increaſe is come to a certain Point, then it can force the Ducts that open into the Womb : By this we ſee that the Menſtrua come on certain Times. If Women always tranſpired equally, and if the Impreſſions that the Seaſons make on them were always the ſame, the Menſtrua would happen on that Moment ; for it would always appear when the Blood was found ſtrong enough to force a Paſſage thro' the Ducts of the Womb. There is but a given Quantity ſufficient for that ; but the Paſſions, Seaſons, Exerciſes, and Aliments, are the Occaſion of divers changes : hence it is that theſe Menſtrua vary often. Thoſe Women who are more exact, obſerve a great deal of Variety in their Menſtrua ; yet the Differences that they ordinarily find, amounts to one or two Days, more or leſs. If in Women who perform Exerciſes, or are ſubject to Paſſions, the Periods appear exact, this proceeds becauſe the Cauſes that ſhould vary the Menſtrua, are compenſated by other things.

There are many Obſervations to be made on the Variety of the Menſtrua: we muſt not be ſurprized to ſee, that according to the different Conſtitutions, the Menſes have divers Periods. Bilious Women are lean, choleric, inclined to venereal Pleaſures, have a ſtrong Pulſe, are full of Blood, there Menſes flow ſooner, and have leſs Intervals. In hot Climates the Menſtrua flow before the Age of fourteen, and are very abounding: as the Heat rarefies the Body, this muſt not appear ſurprizing. The contrary happens in cold Climates, and this is confirm'd by Experience: we have nothing to do but find out what it is that can fill or empty the Veſſels, open the Pores or cloſe them; we ſhall in all this find Cauſes that will diverſify the menſtrual Flux. Women that eat much have more Blood than others. Lean Women, as we have ſaid, have larger Veſſels than thoſe who are fat. Thoſe who have a moiſt Conſtitution have their Veſſels alſo more filled: hence it follows, that their Menſes will flow ſooner, and will be more conſiderable: but as they are more frequent and more abounding, they will laſt longer; when in Women who are very fat, they end ſooner; they have not their Menſtrua till the Age of thirty five, according to the Obſervation of *Forreſtus.* We ſee again, that according to the Age, the Menſes may ſometimes vary. They return once in three Months, ſometimes once in a Year.

All this now mentioned proves that a Plethora is the Cauſe of the periodick Flux of Women. We may add for the laſt Proof, that bleeding retards the Menſtrua, and that *Highmore* found the Veſſels very much diſtended in Women who died during the menſtrual Flux; but we ſhall better ſee the Truth of this Opinion if we obſerve that the Phænomena attending theſe Fluxes proceed from the Plethora. 1*ſt*, Women feel a greater Heat, becauſe the Blood being in a greater Quantity, Motion muſt be more violent throughout all the Body; if this Motion is too ſtrong, it cauſes ſomewhat of a Fever. 2*dly*, As by a Plethora the Canals are dilated, there will be a little ſort of a Pain in the Parts that will be inflated, and therefore the Pain will be perceived in the Loins; and becauſe the Loins and the Thighs have Nerves that communicate with thoſe of the Uterus, there will be alſo ſome Pain in the Thighs; for the Suppreſſion of Women with Child will not cauſe the ſame Pain, becauſe the Blood dilates not the Veſſels but nouriſhes the Fœtus. 3*dly*, In a Plethora the Veſſels of the Head are found more dilated, there will conſequently be felt a Heavineſs and Head-ach. 4*thly*, There muſt be a wearineſs in the Thighs becauſe of the Compreſſion of the Nerves that go from the Sacrum to the Thighs; beſides, that the Difficulty the Blood meets with in circulating ought ſtill to produce this Effect: the ſame happens when Urine is long compreſs'd. 5*thly*, Appetite diminiſhes, becauſe the Veſſels of the Stomach being too much diſtended compreſs the Nerves, diminiſh their Senſation, and thereby hinder the Stomach from contracting, which is neceſſary to create an Appetite. 6*thly*, A Languor ſeizes all the Body, the Weight of the Blood and Compreſſion of the Nerves cauſed by the Plethora produce this Effect. Men are ſubject to the ſame Inconveniencies when they have periodic Evacuations, as obſerved by *Sanctorius*: thoſe who are drunk prove likewiſe the ſame Symptoms, and it is this that demonſtrates a Plethora to be the true Cauſe of it in Women. 7*thly*, The Breaſts are inflated before the menſtrual Flux, for the epigaſtric Arteries communicate with the Veins of the Mammæ; for when the Blood inflates the Womb and remains there, it is neceſſary that a greater Quantity ſhould flow in the epigaſtric Arteries, and conſequently in the Mammæ, beſide the Iliac Arteries being compreſs'd muſt produce the ſame Effect; this is another Proof of a Plethora. We may add, that thoſe who lead a ſedentary Life are moſt ſubject to ſuch Symptoms, for Reſt contributes much to a Plethora. After having explained how a Plethora produces periodic Evacuations, we muſt demonſtrate why theſe Evacuations begin not before the Age of thirteen or fourteen Years, and why they terminate at about the fiftieth. In young Women the Fibres have no Force, they reſiſt not much the Force of the Blood in the Strainers, therefore Tranſpiration and Sweat are more abounding, beſides one part of the Blood is employed to nouriſh and augment the Bulk of the Body; thus there is no Plethora in the time of Infancy, but in time the Fibres become hard, the Body grows not ſo much, and therefore Nature employs leſs Blood in nouriſhing the Parts, and Tranſpiration is in ſome degree leſſened; nevertheleſs as the Body ſtill augments, Evacuation will not be ſo abounding as ſome Years after: when Women arrive at the Age of fifty the Fibres ſtiffen, the Orifices of the Veſſels of the Womb become callous; this happens ſometimes to the hemorrhoidal Veſſels for the ſame Reaſon. But it may be objected, why are not thoſe Women ſubject to the ſame dangerous Symptoms, as thoſe are who have their Menſtrua ſuppreſs'd at the Age of twenty? If the Suppreſſion were ſudden they would be followed by the ſame Symptoms, but as the Fibres harden by Degrees, ſo would Evacuation ceaſe alſo by Degrees; while menſtrual Fluxes diminiſh, ſenſible Evacuations augment;

this is confirmed by the Obſervations of *Sanctorius.* The Plethora is not ſo full in the ſanguinary Veſſels; beſides, there generally are leſs Humours in Perſons advanced in Years than in others. All this undoubtedly may free Women whoſe Menſtrua ceaſe at fifty from Symptoms that attend thoſe of twenty five, but we muſt acknowledge that very often they are ſubject to great Inconveniencies, as is confirmed by Obſervations. In general Women with Child have not their Menſtrua; this muſt not appear ſurprizing, there is no fulneſs in their Veſſels, ſince the Fœtus is nouriſhed and formed from their Blood. Nevertheleſs, if Women are of a moiſt Conſtitution, the Menſtrua do ſometimes flow during their being with Child; this muſt neceſſarily happen, if the fulneſs of the Veſſels is not ſufficiently diminiſhed by the Fluids that enter in the Fœtus. Thoſe who have their Menſtrua while with Child have them commonly but in the three firſt Months, the Fœtus growing afterwards takes away a larger Quantity of Fluid. If through any Diſorder the Menſes flow during the Pregnancy, the Infants are, according to *Hippocrates*, Valetudinarians; the Reaſon of this is evident. If the Fluids flow the Fœtus is deprived of part of its Nouriſhment; according to the ſame Mechaniſm Women that have Milk ſhould not be ſubject to Menſtrua. Evacuations that happen to ſome Women by the Hemorrhoides, Pores of the Skin, Noſe, *&c.* are depending on the ſame Cauſe, they counterbalance thoſe of the Uterus; in theſe Caſes bleeding is of great help in preventing theſe fatal Conſequences. As for extraordinary Evacuations, *Platerus* gives us an Account of a Woman whoſe Womb was taken from her, and who every Month was ſubject to an hemorrhoidal Flux. *Zacutus* tells us of the Menſes periodically flowing in ſome Women from the Thumb; and if the Evacuation was not ſufficient, a Fever or Cephalalgy would enſue. It is reported in the Philoſophical Tranſactions that there was a young Man who at every new Moon loſt Blood through his Thumb, this Flux, that encreaſed with his Age, was ſtopt, this Stoppage was followed by a ſpitting of Blood. We ſee in the ſame Work likewiſe that a Man was ſubject to a Flux of Blood every Month through the fore-Finger; if this Evacuation was ſtopt there enſued Pains in the Arm; the longer its delay the more it abounded, it augmented more through the exceſs of eating and drinking. *Amatius* ſays, that there are Men who have hemorrhoidal Fluxes periodically; this is ſeen very often. *Salmuth* ſpeaks of a ſtill more rare Caſe; he ſays, a Man piſs'd Blood on certain times regularly; this Evacuation was ſtop'd, but a great difficulty of Reſpiration followed it. Men ſubject to this Inconveniency are addicted to the Vapours, when the Blood is ſtopt. The Cauſes that forward the Menſes are a further Proof of what we have already mentioned; for 1*ſt*, the Fever augments the Motion of the Blood, and conſequently the Heat; hence it follows that the Veſſels of the Womb may be forced more eaſily, by the ſame Reaſon there have been Women even at the Age of eighty who were ſubject to their Menſes during the Fever; the ſame happens in the ſmall Pox: we muſt not be ſurprized if this Flux ſtops certain Fevers, as *Hippocrates* obſerved. 2*dly*, Coition gives the Blood a greater Motion, throws the Parts of Generation into Convulſions, it muſt therefore propel the Blood ſometimes in the Cavity of the Womb. 3*dly*, If we drink ſpirituous Liquors to exceſs the Maſs of Blood will rarefy and augment. 4*thly*, Violent Motions propel the Blood with force, and may conſequently help them to force the Veſſels of the Womb; hence it is that when Women dance the Menſes ſometimes flow ſuddenly. *5thly*, Vomiting, Sneezing, Anger, are violent Motions, and therefore produce ſuch Effects; we muſt alſo conſider the Action of Medicines uſed to provoke the Menſes.

The Cauſes that diminiſh or retard the Menſes prove that they are cauſed by a Plethora. *1ſt*, Cold retards the Menſes, ſince the Veſſels are cloſed and the Blood grows thicker; if the Cold is felt in ſome diſtant part in the time of the Courſes, the Flux muſt be augmented, becauſe the Veſſels contract in that Part and Tranſpiration is there ſtopt, than the Plethora encreaſed muſt produce more conſiderable Effects; hence we ſee that cold Linnen renews the Courſes when we thought them at an end. *2dly*, Melancholy at leaſt cauſes a ſlower Motion in the Blood, it will therefore ſtop the Menſes; ſudden Frights produce the ſame Effect. *3dly*, Baths that provoke Sweat, Ulcers and Iſſues that diminiſh the Humours, Tea that promotes Urine, Salivation, Dropſy, by diverting the Humours out of the Veſſels, all theſe Cauſes diminiſh the Plethora, and conſequently the Menſes: we may add to this all thoſe Aliments that render the Blood more viſcous, as Milk, &c. I omit Aſtringents, we ſee what Effects they may produce. We have ſhewn ſome Symptoms that follow the Suppreſſion of the Menſes, but there are other very dangerous ones, plainly ſhewing the Plethora to be the Cauſe of the Menſtrua. *1ſt*, The Arteries beat ſtronger, for if they are diſtended, the Maſs of Blood that they contain will be much larger, conſequently the Motion of that Blood will be greater. *2dly*, The Veſſels of the Spine of the Back are inflated, thus the Nerves are contracted, and therefore there muſt be ſome Pain felt there. *3dly*, The Blood

being

being more heated the Seroſity coagulates; this happens through the Diſſipation of the aqueous Matter that leaves nothing but the viſcous Parts; this granted there may enſue a Fever, which will begin from a Cold. For firſt the viſcous Matter will ſtop in the capillary Veſſels; *2dly*, The Veſſels that compoſe the ſides of others cannot be very much extended, becauſe the Blood being very viſcous can't penetrate; hence follows a Relaxation in the Veſſels; we may likewiſe affirm that the Nerves will be relaxed, ſince that viſcous Subſtance will hinder the Filtration of a Matter proper to give them Tenſion: this ſtated, there will ſcarce be any Motion left in the arterial Extremities, a cold will then be felt, ſince there will be a great Diminution in the Heat that conſiſts only in Motion; but as the Heart is continually beating, the Blood is gathered in the Arteries obſtructed by the viſcous Matter; theſe Veſſels will be then more diſtended; this Diſtenſion will ſoon cauſe a ſtronger Pulſe; laſtly, as the Heart will find Reſiſtance in the Arteries its Motion will augment, for the Action of the Arteries becoming ſtronger, that of the Heart muſt become the ſame, ſince they act againſt it, the ſame as it acts againſt them; beſide as the Blood is accumulated in the Arteries of the Brain, theſe Arteries that beat ſtronger act upon the Nerves, that in their turn act upon the Heart; all this muſt produce a Fever, which happens as *Hippocrates* and *Foreſtus* obſerved. *4thly*, As the Uterus inflated, the Iliac Veins that are compreſs'd can occaſion *Varices*. *5thly*, The Arteries that run at the Articulations being inflated will cauſe there great Pains. *6thly*, The Blood not being able to circulate well, the Lymph will not be able to re-enter into the Blood; a Dropſy will therefore ſometimes enſue the Suppreſſion of the Menſtrua, for the ſame Reaſon that it happens to Dogs and other Animals whoſe Veins have been tied. *7thly*, As the Veſſels of the Womb are wrinkled during the Suppreſſion, the Veſſels or the Strainers of the Inteſtines are even wrinkled ſo by the ſame Cauſes; there will be therefore but a little Lymph filtrated in the Inteſtines, the Excrements conſequently will not be diluted, thus they will be coſtive. *8thly*, The Glands of the Trachea, the Arteries and the Veſicles of the Lungs muſt be inflated, and that Inflation excites the Cough, as appears in phthiſical People who have Tubercles on the Lungs; this ſame Inflation of the Lungs may cauſe an Aſthma, and laſtly, the Conſumption: we ſhall hereafter ſee how the Palpitation proceeds from the Plethora. *9thly*, The Veſſels of the Head being inflated, thoſe that accompany the optic Nerve will be ſo too; this Inflation muſt make it beat ſtronger; this Pulſation will ſhake the optic Nerves, that in receiving diverſe Impreſſions on all ſides make the Objects ſeem to move; and thus a Plethora cauſes a *Vertigo*. An Apoplexy may follow the Inflation of the Veſſels of the Head, as we ſee by Experience; and we may alſo eaſily ſee, that a *Delirium* which proceeds from nothing but a violent Motion of the Blood in the Brain, may often be produced in Suppreſſions of the Menſes. *10thly*, If the Blood is too thick to paſs through the Strainers of the Womb, the ſerous Part will be fine enough to find a Paſſage, and hence the *Fluor Albus* or *Whites*. *11thly*, The hyſteric Paſſion is nothing but a Convulſion, or beginning of one; it is evident, becauſe Experience teaches us that a Plethora can cauſe Convulſions. *12thly*, The Adheſion of the Bladder to the Womb ſhews that there may be found ſome Difference in the Secretion of the Urine. *13thly*, Laſtly the Paſſage of the Blood in the Uterus being cloſed, the Matter that ſhould have run through the ordinary Veſſels will make an Eruption ſomewhere elſe; but this will ſooner happen to Maidens than to thoſe who have had Children, becauſe theſe have the Veſſels of the Uterus dilated.

All the Symptoms of the Menſes or their Obſtructions are perfectly well explained by the Doctrine of a Plethora; thoſe that follow too large Evacuations are explained after the ſame manner. 1*ſt*, Too great Evacuations by the Menſes are attended by Weakneſs; as Strength depends on the Tenſion of the Veſſels, it is no wonder that it is diminiſh'd by the Loſs of Blood. 2*dly*, A Syncope will ſometimes follow, for this is nothing but a ſudden Weakneſs, with but very little Reſpiration; this proceeds from the Reſiſtance of the empty Veſſels againſt the Heart, which not having Force enough, that Obſtacle cannot propel the Blood. 3*dly*, As the Veſſels are not filled, the Motion will be very ſlow, in Places diſtant from the Heart; hence it is that Cold is felt at the Extremities. 4*thly*, The ſanguinary Veſſels not being filled cannot propel the Blood in the capillary Veſſels that creep along the Skin, and conſequently the outward part of the Body will appear very pale. 5*thly*, The Blood not filling all the Veſſels will ſtop in certain Places; when it is ſtop'd it will enter ſuddenly into the adjacent Muſcles, and that is the Convulſion: if this Convulſion attacks the Muſcle of the Pharynx there will enſue a Suffocation; the ſame thing may happen by the violent Motions of Reſpiration. 6*thly*, By theſe Evacuations the Fibres of the Veſſels being cloſed can be deprived of their Nutrition, and an hectic Fever will enſue.

Some aſk whether the Menſtrua flow through the Vagina or the Womb; it has been aſſerted the Vagina. 1*ſt*, Becauſe in dead Women there was no Blood found but in the Vagina. 2*dly*, Becauſe Women with Child have ſometimes their Menſes. But *Morgagni* has put it out of doubt that they flow through the Womb, he always found ſmall black Spots in the Womb: theſe ſmall Spots were as Veſicles out of which the Blood flowed when preſs'd; nevertheleſs it is poſſible that the Blood may flow alſo through the Vagina.

REMARK XXX. *On the Ovaria.*

TWO Inches from the Womb laterally are ſituated two Ovaria, on each ſide one; there are two ſtrong Ligaments that connect them to the Uterus; the Membrane or internal Lamina of the *Peritonæum* faſtens them by its Foldings in their Situation; they are rough, incloſed in a ſtrong Membrane; the Spermatic, Hypogaſtric and ſome other Arteries furniſh them with Blood. Theſe Veſſels are ſo united before they enter the Ovaria that they ſeem to form but one Veſſel with the *Plexus Reticulares*; theſe Veſſels are attended by Nerves: they are ſo interwoven together in order to compoſe the Structure of the Ovaria, that we cannot deſcribe them. On the Surface of the Ovaria, under the Membrane that environs it, there are little Globules fixed to the Subſtance of the Ovaria by a kind of *Calix*; they contain a lymphatic Humour that coagulates by the Heat of the Fire; they are compoſed of two concentrick Membranes firmly joined together. The Ovaria are in all Women; they are very ſmall in Girls before the Age of twelve or thirteen, but in old Women they diminiſh; their moſt conſiderable Bigneſs is at the time when they are fitteſt for Procreation. The ſmall Veſiculæ are connected to the Extremities of the Veſſels here mentioned; they ſcarce appear but after Coition; they then become more tranſparent; their Membranes thicken, their Swelling raiſes the Membrane of the Ovaria in the Form of Nipples, in ſuch a manner that they appear pendent; they ſeparate at laſt, and leave a concave *Matrix* in the Subſtance of the Ovaria; the Membrane is opened by the Force that cauſes the Egg to fall, and the Cicatrix then cloſes by Degrees.

It has not without any ſolid Proofs been advanced that the Fœtus is formed from that Egg which we have ſaid to drop. 1*ſt*, All Animals have Ovaria. 2*dly*, *Riolan*, *Graaf*, *Eltſholtius* affirm they found Fœtus's in the Ducts through which theſe Ova paſs. 3*dly*, Not long ſince we had a very memorable Example of a Fœtus that was found in the Tubes, it was taken out at the Age of twenty one Months; the Mother did not die in the Operation. 4*thly*, *Ruyſch* lately ſhewed an Egg fallen, and the Tube turned toward the Ovaria to receive the Ovum. 5*thly*, *Nuk*'s Experiment puts this Opinion out of doubt: that Anatomiſt took a Bitch three Days after ſhe was covered, he found two Eggs which were much ſwoln in the Ovary; he tied the *Fallopian* Tube of the Womb that was towards thoſe Ova, he cloſed the Wound, and twenty one Days after having opened the Bitch, he ſaw two Fœtus's in the *Fallopian* Tube between the Ligature and the Ovary.

Ruyſch remarked, that when the *Ovum* is fallen, the Place wherein it was before is ſpongeous and environ'd with little red Fibrils; this ſpongy Body is nothing but a yellowiſh Gland, obſerved by *Graaf*; it takes up generally the greateſt part of the Ovarium. *Bohn* obſerved, that it appeared better after Coition, at other times it is leſs ſenſible, becauſe it ſhrinks. *Malpighi* obſerved it in Women with Child and in thoſe that were not

ſo;

ſo; this ſhews it not to be an effect of Conception, as *Bohn* advanced; it exiſts before the *Ovum* appears; it is very likely that it contains it, and that it is formed from the Veſicles that always appear in the Ovaria; at firſt it is ſmall, then bigger. *Malpighi* has really ſhewn in the ſame Ovary many Bodies like that Gland; he ſays, that in ſome Ovaria which he boiled there were ſeveral Veſſels ſwelled by a yellowiſh Juice. *Fallopius* made the ſame Remark. "All Anatomiſts, ſays he, affirm "that the Seed is formed in the Teſticles of the "Women; I never could diſcover that: it is "true I have obſerved Veſſels, ſome of which "contained an aqueous Humour, others a yel-"lowiſh, &c." *Malpighi* has purſued this Diſcovery farther; according to his Obſervations, this glandular Body at laſt grows as large as a Cherry; it is environ'd with fleſhy Fibres, and preſents to the external part of the Ovary a kind of Nipple: In its Cavity is contained a Veſicle or *Ovum*, the ſame as a Stone of a Fruit, hung to a vaſcular Appendix as a Fruit at its Stalk; this Cavity being emptied by the fall of the *Ovum*, appears conſiderable enough; we find it ſometimes turned in the ſame manner as the Prepuce when the Glans is diſcovered, after that it diſappears. *Malpighi* obſerved this glandular Body in Cows a little before or after they had been covered. When the Parts of Generation are agitated by Convulſions this Gland is ſwelled, its Nipple appears more, and by the Inflammation which there ſucceeds, the Coat that environs the Ovaria breaks under this Nipple, the fleſhy Fibres of the Gland by their Contraction puſh the Veſicle or the *Ovum* that falls into the Tubes: we ſhall now give the Deſcription of them.

REMARK XXXI. *Of the Fallopian Tubes.*

WE ſaid that at the ſides of the Womb there were two Wings or Pleats called the broad Ligaments; we ſee alſo two other Wings under the Tubes, they adhere to the Ovarium, and conſequently may be drawn towards it. In the Cavity of the Tubes we find, Wrinkles perceived moſtly at the Orifice, and are continued through the whole Extent; theſe Wrinkles or Pleats are formed by the Preſſure of the external Coat on the internal, and permit the Tubes to widen when the Ovaria are fallen in the Cavity of the Tubes.

At the end of the Tubes are Fringes environing the Orifice; ſometimes they hang downwards, ſometimes they are ſtrait; there is no doubt but that they ſtraiten and embrace the Ovarium. *Ruyſch* found them ſo; it is then when the *Ovum* looſens and falls into the Tubes. The Reaſon why the Tubes become ſtrait is better demonſtrated than deſcribed; their Diſpoſition is ſuch, that when we inject into the Veſſels that enter there they become ſtrait directly; in Coition all the Veſſels being inflated produce this Effect. The Ova being looſe enter into the Cavity of the Tubes preſſed by the Compreſſion of the *Fimbriæ*; as the Canal is larger at the Entrance, the *Ovum* enters eaſily, and afterwards the Tenſion of the Veſſels; their Pulſation, ſwelling, which are more conſiderable in proportion as the Tubes are diſtant from the Ovarium, propel that Ovum towards the Cavity of the Uterus, and there precipitates them: if by any Accident the Ovum remains in the Tubes, it muſt neceſſarily cauſe the Death of the Mother on the third or fourth Month; the Fœtus in dilating will break the Tubes.

When the Ovum is fallen, it either ſtays in the Womb, if fruitful, or is expell'd by Compreſſion. It is difficult enough to give a mechanic Cauſe to ſhew why the fertile Ovum ought to be kept, and that which is barren muſt be expelled; all the Difference that is there found is, that the one has received the Vapours from the maſculine Seed, and the other has not; the Vapour cannot but ſwell the Ova, and perhaps irritate the Womb. How doth this Inflation contribute to retain the Ovum? It is not difficult to ſee, that if this Inflation came to a certain Point the Ovum could no more iſſue out, neither is it impoſſible for the Seed to contract the Womb. This Fluid may extend theſe Fibres, as Injections do; perhaps alſo the Action of the *Semen* expreſſes a clammy Humour that is found at the Entry of the Neck of the Womb, according to the Obſervations of *Morgagni*; for the Seed which *Ruyſch* ſays he found in the Womb and Tubes of a Woman that was killed by her Huſband who ſurpriſed her in the Fact of Adultery, was certainly a Matter preſs'd from the Womb.

It is certain that Man is formed from thoſe Ova, but how is he formed there? that cannot be determined; may be the *Animalcula* whence we ſpring is formed in the Man; that is the Opinion of ſome. The animal Seed, ſay they, is filled with *Animalculæ*; it is ſyringed in the Womb through the Orifice that opens then by the convulſive Motions, and Relaxation of the Valves which being ſprinkled by the Juice preſs'd from the Womb, eaſily yield in their inferior part, which is free. Theſe Valves, for the moſt part, are formed by the Wrinkles of the Neck of the Womb internally; they come between the longitudinal Fibres, being free downwards; they permit Fluids that come from without, to enter the Womb, but permit not the return ſo eaſily; the ſame as the Vagina moiſtened by the Act of Coition is relaxed, the Orifice of the Uterus relaxes alſo: but the Heat of the Seed which is there injected cauſes a Drineſs, that can contribute to cloſe the Orifice; the *Animalculæ* that reſiſt againſt this Heat (for a very moderate Heat kills them) are inſinuated into the Ovum by aſcending through the Tubes, or dying in the way. The Heat or the Animal Spirit that comes from the Man ſhakes the nervous Papillæ; theſe Papillæ cauſe Convulſions, which cloſing the Orifice hinder the Exit of the Ovum; round Veſicles placed at the Orifice expreſs a tenacious Matter, or a kind of Paſte, that hinders Bodies from incommoding the Fœtus.

This is the mechanical Account of the Fall of the Ovum, and its being retained in the Womb; we have ſaid elſewhere what we ought to think of the Animalculæ of the Seed; it may be that the Fœtus is there found, and that the Seed doth nothing but unfold it; may be plaſtic Nature forms it, or the Creator by an Act of his omnipotent Will mixes it with Seed and the Subſtance of the Ovum. All that can be ſaid againſt this Opinion is, that if the Creator, or the plaſtic Natures thus formed the Fœtus, there had been no Neceſſity for the Compoſition of ſuch a Machine: The Opinion of thoſe who ſay the Animal is found whole in the Egg, and that there happens nothing but an unfolding, agrees with the Mechaniſm; but on the other ſide the Difficulties are very great, as we have before obſerved. Mr. *Lami* pretended to give a Cauſe of the Formation of the Fœtus: but I dare ſay we muſt be out of our Senſes to ſeek it any where elſe than in the infinite Power and Action of the Creator. Can we ſay with that Phyſician, that Parts that have an Affinity with the Head form the Head, that thoſe which have an Affinity with the Breaſt are diſpoſed by the Laws of Motion to compoſe the Breaſt? Is there any one Idea that can perſuade us of the leaſt Poſſibility of all that? I would rather ſay the Creator from the Beginning formed all Animals; that he ſpread them through all the World; that theſe little Beings circulate every where; that when they find a Matrix fit for them they reſt there; in Men for Example, the human Animals reſt in their Teſticles, whence by the Laws of Mechaniſm they are ejected, afterwards they do nothing but extend: this Hypotheſis has many Difficulties, but it is more reaſonable than the other: Let us view the Parts that contain or nouriſh the Fœtus.

REMARK XXXII. *On the Membranes of the Fœtus.*

THERE have been many Diſputes concerning the Allantoides; ſome affirmed they were in the human Fœtus as well as in Beaſts; it ſeems that Nature as ſhe gave it to one Animal ſhould have given it to all; it receives the Urine in Animals, muſt not the human Fœtus have the ſame Reſervoir? *Drelincourt* ſaid, that thoſe who acknowledged the Allantoides in Animals were more like Brutes than rational Anatomiſts.

Needham, *Graaf*, and *Bidloo*, ſay they, obſerved it; *Munich* writ that he ſhewed it publickly at the Hoſpital of *Utrecht*; *Verheyen* miſtruſting thoſe Proofs would not believe what he did not ſee. Theſe Gentlemen, who were very happy in finding that Membrane, ſhould have given an exact Account of it; Anatomiſts then would not have found it difficult to have agreed.

But how doth the Fœtus diſcharge its Urine? *Riolan* and *Veſlingius* anſwer, that the Urine is gathered in the Bladder of the Fœtus, and therefore this Receptacle is larger in the Fœtus than in an Adult: But doth not the Fœtus piſs as well as an Adult? Are not the Fibres irritated by the Urine? Do not the Muſcles of the Abdomen preſs it? Is there any Obſtacle that oppoſes the Exit of the Urine? In all this we find nothing to defend the Opinion of thoſe Anatomiſts, but what rather confutes it.

Drelincourt advanced, that the Fœtus piſs'd in the Cavity of the *Amnios*, and that he ſuck'd the Urine again by his Mouth, but that is difficult to be believed. The Urine ſeparated from the Blood alkaliſes by the Heat; thus it would incommode the Fœtus conſiderably. To this Difficulty, thoſe who defend the abovementioned Opinion anſwer, that the Urine which is ſeparated in the Fœtus is not acrimonious: The Blood that enters the Fœtus, or the Milk of which the Blood is indeed formed, leaves the Urine, or at leaſt a part of it in the Mother. But can't we ſay the ſame thing of Milk that nouriſhes Children, and yet don't they piſs much? and is not their Urine as acrimonious as that of Adults? This is a Difficulty ſtarted againſt the Opinion of *Riolan*. We ſay the Sphincter of the Bladder always reſiſts, that it can't be ſurmounted but by the Preſſure of the Diaphragm; that the Diaphragm cannot act, ſince the Fœtus piſſes not; theſe are Reaſons of one ſide and the other; but this is the Opinion of *Boerhaave*. The Kidneys, ſays he, are proportionably larger in the Fœtus than in Adults; they continually ſecrete the Urine which they filtrate, but that is not an acrimonious Urine, it is ſweet;

the Sphincter permits not its Exit, becauſe it is Inſpiration that in preſſing the Bladder obliges the Sphincter to yield; when the Urine is too abounding, it paſſes through a membranous Canal that riſes from the bottom of the Bladder, and goes out with the Navel String through the Navel; this Duct goes to the Root of the Placenta, where it terminates to an oval Bladder compoſed of a Membrane finer than the others; we may ſee the *Engliſh* Philoſophical Tranſactions of 1700, and 1701, and the tenth Theſis of *Ruyſch*, tho' this Anatomiſt is not of our Opinion; theſe are the principal Opinions on the Urine of the Fœtus. All Diſputes muſt diſappear at the Sight of the Allantoides, which is found the ſame in the human Fœtus as in Animals, but it is not ſituated in the ſame manner.

The ſecond Coat is the Amnios as we have ſaid, it is fill'd with a Fluid in which the Fœtus ſwims: it is aſked whence this Fluid comes? there have been great diſputes concerning this: *Bohn* advanc'd that it is filtrated from the Breaſts; it cannot be imagined that two ſuch ſmall Filtres could furniſh ſo great a quantity; it is very ſeldom that we can preſs the Milk out of the Breaſts of new born Children; they are not always filled with the ſerous Milk that is ſometimes found there: in Women with Child, do we ſee their Milk from their inflated Breaſts? *Drelincourt*, as we have already mentioned, believ'd this Fluid was nothing but Urine, but all the reaſons that we have given are contrary to this opinion; there is no appearance, ſince Nature would not let the Fœtus of Animals ſwim in their Urine, that the human Fœtus ſhould ſwim in it; this is not the only Hypotheſis which we have had recourſe to, to explain that Phænomenon. There are Authors who imagined that the Fœtus filled the Cavity of the Amnios with its Tears, Saliva, and Sweat; but can we imagine that thoſe Secretions are ſufficient enough for that purpoſe? There is a greater appearance that the Fluid of the Amnios comes from another place: we ſhall explain how it is filtrated after we have had a view of the Placenta.

REMARK XXXIII. *Of the* Placenta.

THE Ovum being fallen into the Cavity of the Womb, is heated, inflated, and nouriſhed by the ſeminal Spirit, it always dilates more; in the 1*ſt* days of Conception, it is ſtill floating in the Uterus; but in the time of its extending, the ſmall Veſſels that fixed it before to the Ovary, are alſo elongated, and in elongating they enter the little Tubes that are in the Uterus, and reſemble thoſe in the Breaſts; the ſame things that happen to the ſeed of Plants, happen here: A grain of Corn ſwells, and is unfolded by moiſtneſs; the young Bud ſhoots out ſmall Roots that enter into the Earth; thro' the ſmall Ducts in the Roots the nouriſhng Juice always riſes. 1*ſt*, The Grain being in the Earth, the Atmoſphere by its weight forces the Juice into the ſubſtance of that Grain; that Juice continually propel'd by another, cauſes the Bud to ſhoot on all Sides. 2*dly*, The Ovum in the like manner falling into the Uterus, is extended by the Juice that is propelled there; as it is preſſed by the Contraction of the Womb, the ſmall Veſſels that are extended enter the Lacunæ, thro' which flow the Menſtrual Fluxes. 3*dly*, In the beginning, as we ſee by what we have above-mentioned, the Placenta and the Fœtus grow not by the ſame Cauſe that extends them afterwards; for before the little Veſſels inoſculate with thoſe of the Womb, there muſt neceſſarily be a Cauſe that extends them; this Cauſe can be nothing but the Spirit of the *Semen Maſculinum*, and therefore it is that the Ova, which fall by the laſcivious Motions of Women, without Coition, fix not to the ſmall Lacunæ now mention'd; they want the firſt Principle of Accretion that proceeds from the *Semen Maſculinum.*

When theſe Veſſels that part from the Ovum enter the Lacunæ of the Womb, they are not directly open enough to receive much of the maternal Juice; hence the Menſtrua flow in certain Women during the three firſt Months; but as thoſe Ducts dilate by degrees, the ſuperfluous Blood that cauſes the Plethora in Women is diſcharged into them.

The ſmall Ducts that end at the Womb, are upon the Surface of a very fine Membrane derived from the Chorion; under this Tunic are an infinite number of ſmall Veſſels that come from thoſe we juſt have been ſpeaking of, and receive the Fluids that flow from the Mother; they form by their diverſe Circumvolutions the Body, which we call Placenta; there is not one Gland obſerved in it, but there are Ducts and lymphatic Follicles: finally theſe Veſſels in joining together, form a Trunk that enters the Cavity made by the Chorion and Amnios; theſe two Membranes give them a covering. Here follows the Deſcription of this Trunk of Veſſels; it is called the Navel String.

REMARK XXXIV. *Of the Navel String.*

THE 1*ſt* Queſtion we are to examine, is whether the Blood paſſes from the Mother to the Fœtus; here are the Reaſons that induced many to be of this Opinion. 1*ſt*, There is an Hæmorrhage in the Labour; for if the Blood paſſed not from the ſecretory Veſſels of the Womb into the Fœtus, it would not enter into the World when theſe Ducts break from thoſe of the Placenta. 2*dly*, We prove that the Blood paſſes from the Fœtus to the Mother, by an Obſervation related in the Ephemerides of the Royal Academy, 1708. A Woman with Child, ſay they, died of a Wound, and there was no Blood found in the Fœtus; the following are the Reaſons of thoſe that maintain the contrary. 1*ſt*, Say they, we may ſeparate the ſmall Ducts that are in the Chorion from that of the Womb, without Violence, or Loſs of Blood. 2*dly*, In Animals, the Veſſels of the Chorion ſeparated from thoſe of the Uterus, do not loſe Blood, but a ſerous Fluid. 3*dly*, The Fluids that we inject through the Umbilical Arteries, flow not thro' the Placenta, but return thro' the Vein. 4*thly*, There is a Membrane that covers the Placenta, and is contiguous to the Uterus——of theſe two Opinions the latter ſeems to me the moſt likely: The Hæmorrhage that happens in the Flux, proves nothing, the Pains, the Pullings of the Veſſels, the violent Efforts may open a Paſſage to the Blood; the Fact mention'd in the *Ephemerides* of the Royal Academy is not ſufficient to make us embrace this Opinion, we ſhou'd have exactly known all theſe Incidents that happened to this Woman.

The ſecond Queſtion we are to look into, is what Juice the Fœtus receives from the Mother? 1*ſt*, The Veſſels of the Womb are no more preſſed by the Blood in the time of Pregnancy than during another time; it appears that they even ſhould be leſs ſo, for the Fœtus continually receives Juices from the Mother, which cauſe the Plethora we have been ſpeaking of. 2*dly*, The Ducts of the Womb perfectly reſemble thoſe of the Breaſts. 3*dly*, In Animals the Veſſels that were joined to the Uterus diſcharge a milky Fluid——from theſe three Reaſons we may conclude that the Mother furniſhes a Milk that enters the little Ducts of the Chorion, and being carried into the Blood of the Fœtus by the umbilical Vein, undergoes the ſame Changes as in the Infants nouriſhed by Milk.

The *3d* Queſtion we are to examine is, whence proceeds the Fluid found in the Amnios? *1ſt*, It is certain that the Fluid we find in the Amnios is gelatinous, like that that drops from the ſmall Ducts of the Womb. 2*d*, We find even the ſmalleſt Fœtus ſwimming in this Fluid. *3d*, We find this ſame Fluid in the Mouth, Stomach, and Inteſtines of this ſmall Fœtus. *4thly*, *Bergerus* ſays, he kept a Fœtus of the bigneſs of a Bee, a Year. This Fœtus was encloſed in an Ovum, as large as that of a Hen's, and this Ovum was fill'd with a Fluid, the Fœtus ſwam in it, it had its Head inclin'd on its Breaſt, the reſt of the Body bent, its Eyes were diſcover'd by two black Demicircles, a double Membrane compoſed the Ovum, at the external part there was a kind of Root, there were Ramifications of umbilical Veſſels anſwering to that part within. *5thly*, Hence it appears that the Fluid which environs the Fœtus, doth not proceed from the Secretions of the Fœtus; there remain but three ways to explain it.

The milky Juice being carried into the Veſſels of the Fœtus, partly changes into Blood, and is employed for the Accretion of that ſmall Body; afterwards the Blood being carried back into the Placenta, returns by the Vein; in this Paſſage it may by Filtres be ſeparated from the Lymph, leaving in the Strainers the reſt of that milky Juice which from theſe Filtres may be carried into the Cavity of the Amnios; that there remains much of the milky Juice, in the Blood which returns to the Placenta, muſt not be ſurpriſing, for it is immediately carried to the Heart, almoſt without undergoing any Change in the umbilical Veſſels; from the Heart it deſcends thro' the Aorta, and enters the Iliac Arteries; by this ſecond Paſſage it was not much altered, we may even almoſt ſay, that it was not chang'd: ſince to change the Blood it muſt paſs thro' the capillary Extremities which it did not as yet. 2*dly*, There may be Ducts that immediately tranſport the Fluid found there from the Uterus into the Amnios; what we may affirm is, that the Juice of which the Ovum is fill'd at firſt proceeds only from thence; the Veſſels are not yet unfolded enough to receive the Fluids: as there are in Adults, for example, arterial Ducts that carry the Sweat out of the Body, and Veins that carry the Moiſtneſs of the Bath into the Blood; ſo there are Ducts in the Ovum that abſorb the nouriſhing Juice of the Uterus. 3*dly*, It may be that in the time of the Blood's circulating from the Artery into the umbilical Vein, that there are Filtres as well there as in different parts of the Body, to ſecrete the Matter in which the Fœtus ſwims. Of theſe three Ways that which we may ſay furniſhes the Fluid is the laſt, eſpecially when the Fœtus is become large; the Reaſon of it is that in almoſt all the Parts of the Body Secretions are performed at the Orifice of the Arteries and Veins; in all Appearance this Fluid is ſecreted as the Lymph, for the Lymph comes from the Arteries.

The fourth Queſtion we may enquire into is whether the umbilical Veſſels nouriſh the Fœtus? 1*ſt*, There are Obſervations that demonſtrate the Navel not to be ſo abſolutely neceſſary; it was not found in Fœtus's who were perfectly well, and ſtill wanted the umbilical. 2*dly*, Nutrition could not be made the firſt Months in this manner, as we have already ſaid.

From theſe Difficulties they have had recourſe to the Mouth, through the which it was pretended that the Fluid of the *Amnios* entered to nouriſh the Fœtus. *Hippocrates*, as well as *Democritus*, *Epicurus* and *Plutarch*, were of that Opinion. After theſe Philoſophers, *Entius*, *Charleton*, *Bayle*, and *Everhard* defended this Opinion; at laſt Mr. *Heiſter* brought theſe following Reaſons. 1*ſt*, In the Fœtus of a Cow, he found in the Stomach, Œſophagus and Mouth a gelatinous Fluid, continued with that of the *Amnios*, and of the ſame Nature. 2*dly*, There were found Fæces in the Inteſtines. 3*dly*, The Fluid of the *Amnios* is in great Quantity during the firſt Months of Pregnancy, but very little is found in the laſt; it ſeems nothing can conſume it but the Fœtus. 4*thly*, This Fluid is ſo proper for Nouriſhment that nothing better can be wiſhed for. 5*thly*, It ſeems that this Fluid is propel'd in the Œſophagus and Stomach by the Action of the Uterus, which always reſiſts the Dilatation, by the Preſſure of the Muſcles of the Abdomen, and Air that environs the Body of the Mother. 6*thly*, This appears neceſſary, in order that the Œſophagus, Inteſtines, Lacteal Veſſels and Thoracic Canal may open and be accuſtomed to the Functions that they are deſigned for. Mr. *Heiſter* before he gave theſe Reaſons ſaid, that the Fluid that was found in the Œſophagus was like that of the Amnios, and that it was changed in the ſmall Guts; two Objections were made againſt this Opinion. 1*ſt*, That we ſometimes find Fœtus's who have their Mouths ſhut; we anſwer, that this happens but very rarely; that theſe Fœtus's die very ſoon, or that there are other Ducts to receive the Juice of the Amnios. 2*dly*, They ſay the Fœtus's reſpires not, and cannot therefore ſwallow this Fluid; ſome anſwer that we cannot draw Conſequences from the Adult to the Fœtus, that the one cannot perform his Function without Reſpiration, but is not the ſame with the other, who living in theſe Waters need no Preſſure of Air to act. This Anſwer is not ſatisfactory; if the Air is abſolutely neceſſary in the New-born for Deglutition, it is not leſs ſo in the Fœtus; the Organs are the ſame, they have need of the ſame Succour.

Mr. *Heiſter* as well as *Bergerus* affirm with good Reaſon that the Motions of the Mother, Reſpiration and Compreſſion of the Muſcles propel with Force the Juice of the Amnios into the Œſophagus; this is a mechanic Reaſon, while the abovefaid proves nothing, we may therefore affirm that the Fœtus is nouriſhed. 1*ſt*, Partly by the Fluid of the Amnios, and hence we find a Reaſon that demonſtrates the Lacteal Canals to be open. It is true nevertheleſs that we might ſay the Fluids that flow in the Stomach and Inteſtines through the glandular Filtres are abſorbed again by the lacteal Veſſels; we ſee likewiſe that the Fæces ought to be lodged in the large Inteſtines. By the ſame Reaſon that in Children who are nouriſhed by Milk, we may alſo ſay that the ſame thing might happen becauſe of the Subſtances filtrated thro' the inteſtinal Glands. There is only one Difficulty againſt *Heiſter*, viz. 1*ſt*, How the Fœtus would not be incommoded by the vaſt Quantity of Water that might enter its Stomach. 2*dly*, The Fœtus is nouriſhed by the milky Juice that comes to it through the umbilical Vein; this is even the principal Aliment that nouriſhes and gives it Accretion. 3*dly*, During the firſt Day it is nouriſhed by a Fluid we in another Place ſpoke of, ſince the Veſſels are not as yet enough unfolded to receive the Juice that muſt circulate there afterwards, and is too thick to enter there.

The fifth Queſtion to be aſked is, what uſe are the umbilical Arteries of? If they do not carry back the Blood to the Mother, of what Uſe are they in the Placenta. 1*ſt*, The Arteries bring back the Blood to the Placenta to nouriſh it. 2*dly*, To filtrate there the Fluid that enters the Amnios. 3*dly*, To convey the Lymph to the lymphatick Veſſels. 4*thly*, To diſcharge the Fœtus of the great Quantity of Blood that could have incommoded it. 5*thly*, To give Accretion to the ſmall Ducts that enter the Uterus. The Juice that flows from the Womb cannot give them Accretion; all that is in our Body is nouriſhed by Arteries; it is the ſame as in Trees, their Roots are augmented and nouriſhed by the Juice that returns from the Body of the Plant.

REMARK XXXV. *Of the Fœtus.*

WHEN the Ovum is looſened from the Ovary it enters the Tubes that carry it at laſt into the Womb by their Contraction, aided by the Preſſure of the neighbouring Parts, at laſt when it is in the Womb it there adheres cloſely. It at firſt appears like a tranſparent Bulla of Cryſtal; we find a Fluid in this Bulla reſembling the White of an Egg; the Fluid at laſt preſents a kind of Cloud, which afterwards forms the Lineaments of the Fœtus. The firſt thing obſerved to have any Figure is the Head and the two lower Ventricles of the Brain: theſe two Lumps are at firſt repreſented by two Bullæ; that from which the Head ſprings is conſiderably larger than all the reſt. Inſtead of Eyes we perceive two Points in it, the Mouth is expreſs'd by a Line that runs from one Ear to the other; a Noſe is alſo obſerved, although very obſcurely, by a ſmall Filaments perpendicular to the Line we have been ſpeaking of; the Spine and Neck are nothing but very ſmall Filaments, though afterwards they form ſuch ſtrong and conſiderable Parts. In Figures of growing Fœtus's we repreſent the ſuperior and inferior Extremities by a Length proportioned to the Extent, which we afterwards ſee; nevertheleſs we perceive nothing but ſimple Stumps that riſe out of the Body. As for Example, if the Wriſt were planted at the Inſertion of the Humerus, theſe Members lengthen by Degrees and take the Figure that they have in an Adult; in this Stare all the Bones are only membranous or filamentous, they harden and grow according to the Degrees we have elſewhere obſerved. I ſhall not here explain how the young Chicken is formed in the Ovum, as *Malpighi* has done it, it would be foreign to my Purpoſe.

This manner of the Formation of the Fœtus appears, according to ſome, to deſtroy the Opinion of thoſe who advanced that there was nothing but an unfolding of the Parts; if the Parts did nothing but extend, we ſhould ſee them appear otherwiſe than in Bullæ, beſide, they would not appear ſucceſſively; this Difficulty is of great Conſequence, though it was anſwered, that the Parts already organiſed may be inflated one after the other.

As many Ova as there fall in the Womb ſo many Fœtus's are produced; nevertheleſs from one Ovum may ſpring Twins; thoſe that are formed from two Ova have each their Coats and Placenta ſeparated; thoſe that ſpring from one only have often at leaſt one common Coat. The Caſe obſerved by *Steno* happens rarely; this Anatomiſt ſays, he found three Fœtus's contained in one common Membrane, and wrapt each in a different Amnios. Twins that are found in one Tegument are commonly ſubject to Abortion; they are alſo diverſly united and form monſtrous Conjunctions; as the Fœtus's are united, ſo there are formed Lumps of different Placentæ, and ſometimes one, two and three are found united together.

How can two, three or four Fœtus's have the ſame Placenta, a particular Navel String and Membrane? The Reaſon of it is, that many Ova are united to the ſame Calix, hence a part of every Ovum is fixed to the Ovary: all theſe Parts form a common Placenta, whence a Navel String goes off towards every Ovum; two Ova may be united together by a *Luſus Naturæ*, ſo that their Cavities form but one, then will the Fœtus be contained in the ſame Membrane. Thus by ſome Accident it may likewiſe happen that the external Membranes of every Ovum are united, while the internal will remain ſeparated; and this is the Caſe of *Steno.* Laſtly, There may be infinite Varieties, according to the Accidents the Parts undergo in the Conformation.

Men are perhaps formed as Edifices, in the building of which the Foundations are firſt laid. It ſeems that all their Parts exiſt not before their unfolding; for this Reaſon there was formerly a Diſpute concerning the Progeneration of the Parts. The Members, ſays *Hippocrates*, grow in the ſame time, but thoſe that are largeſt appear ſooneſt. It is ſuperfluous, ſays *Malpighi*, to aſk whether the Heart is formed before the Brain, or the Blood before the Heart; every thing, according to that great Anatomiſt, exiſts in the ſame time; the Veſſels do nothing but ſwell and extend. *Harvey* pretended the contrary, and with ſome Foundation. There were great Diſputes formerly to know whether the Parts were to be divided into Spermatics and Sanguinary; all the Parts are formed of the ſame Matter. In the Fœtus we ſee nothing red in the firſt Days of its Formation, afterwards the circulating Fluids in paſſing through the Filtres take a red Tincture; theſe Fluids thus redden'd give their Colour to the Parts that have Veſſels large enough to let them paſs; the others that are too ſtrait are not filled but by a white and milky Fluid. *Bergerus* tells us, that in a Mole filled with Blood Veſſels he found a Veſicle as large as a Pigeon's Egg, and full of a cryſtalline Lymph, the Embrio ſwam in it; it was as large as a great Ant, and ſeemed formed of a milky Subſtance: it was fixed to a little String; the Body ſeemed to have a ſmall Curvature; the Lineaments of the Head, Eyes and Members were clearly diſtinguiſhed, but we could not perceive any Trace of Blood there was, but the external Part fixed to the Mola, which appeared red; we ſaw perfectly well the Fibres that ſprung from the Navel String, and its Roots whence the Placenta ſhould have taken its riſe.

The Fœtus's unite ſometimes and form monſtrous Bodies; were there in the Ovum monſtrous Embryo's? Or were theſe Monſters formed afterwards by a ſimple Union? by a *Luſus Naturæ* the Lineaments of a Monſter might be traced in the Egg. But firſt, it is certain the Imagination multiplies the Parts of the Fœtus in ſeveral Caſes; there have been Examples that Women with Child, after being ſtruck with the Idea of a Monſter, have brought forth Monſters. 2*dly*, We daily ſee Children wear the Marks of their Mother's longings. 3*dly*, As fleſh joins, ſo by diverſe Accidents the two Embryos, when they appear nothing but a milky Subſtance, may be joined one to another.

There have been Philoſophers who would explain the Effects of Imagination on the Fœtus; none but ſuperficial Wits can give ſatisfactory Ex-

plications;

plications; we know nothing in the human Body but Matter and Motion. When a Mother is ſtruck with ſome Object the Motion encreaſes in her Body, becauſe of the Trouble that riſes in her Soul; this Motion cannot be communicated to the Fœtus but by theſe two Ways. 1*ſt*, The Blood and the Nerves of the Mother agitate the Womb; this Agitation cauſes diverſe Oſcillations in the Veſſels, or in the Roots that fix the Placenta to the Womb; theſe Oſcillations cannot but contract or dilate the Veſſels; what will this Dilatation or Contraction produce? A Motion more or leſs rapid in the Fluids; but that Velocity or Lentor will be equal throughout all the Body, therefore one part will not be more ſhaken than the other. Let us even ſuppoſe that Motion augments in one Part: can this Velocity only form a Part organis'd with all the Proportions, and like to that which ſtrikes the Eye of the Mother? We muſt either be very blind or exceedingly clear-ſighted to conceive ſuch a Phænomenon. 2*dly*, The Motion of the Mother may be communicated to the Child by the Fluids that ſhe ſends thither. But 1*ſt*, the blood paſſes not from one to the other, as we have proved: There is but one ſort of Milk that enters into the Roots of the Placenta; we know how ſlow the Secretions are: hence we may conclude, whether the Augmentation of the Motion can be conſiderable, if nothing but the Milk is the Production of it. 2*dly*, If even the Blood ſhould flow from the Womb into the Fœtus, its Motions would be but very ſlow in the Ramifications of the Placenta; it would run a little ſwifter in the umbilical Vein, but in entring into the different Parts of the Fœtus it prodigiouſly decreaſes. Why, for Example, if carried with equal Swiftneſs to both ſides of the Head, ſhall it form an Excreſcence on one ſide and not on the other? Why will it break the Legs or Arms of the Embryo, becauſe its Mother had ſeen a Man broke upon the Wheel? Why will it form Figures of Animals that preſent themſelves to the Eyes of a Woman with Child?

Since we have ſeen that there was no mechanic Law that can produce this Effect, let us ſee whether there be no other Cauſe. 1*ſt*, If the Creator had eſtabliſhed that at the Occaſions of the Motions and Imaginations of the Mother it ſhould act on the Fœtus conformably to theſe Motions and Imaginations, this might be the Cauſe, but it is not general; there have been Women ſtruck with ſeveral Objects whoſe Impreſſions appeared not in the Fœtus. 2*dly*, If the Creator has eſtabliſhed theſe Laws, it is in all Appearance for other Reaſons, and this Effect muſt be looked upon as one of the Inconveniencies found in moſt part of theſe general Laws, and which the ſupreme Being did not judge *a propos* to make Exceptions againſt. 3*dly*, If we might conjecture in Matters of ſuch Obſcurity, I ſhould ſuſpect that all this proceeded from plaſtic Natures, from which the Creator choſe to form Bodies which receive Souls; theſe ſecundary Cauſes would act according to neceſſary Laws which the Creator had impoſed on them. As their Action would not be voluntary, they would not act but according to the Circumſtances to which a Supreme Law fixes their Action, then a violent Motion would be the Occaſion; according to which, that which gives Form to Matter would modify the Fœtus; that hinders me from laying it again immediately upon the Creator, becauſe they make him produce, without any Reaſon, a new organis'd Being. This Inconvenience is not like that which follows the Laws of Weight for Example: whence a Motion, more or leſs violent, reſults on certain Occaſions that puts the Texture of Bodies out of Order; but here they introduce God working to form Beings of as difficult Productions as the beſt organis'd Bodies, and this without any Neceſſity; we might rather attribute this Work to depending Cauſes that were ordered to modify the Matter, according to diverſe Circumſtances.

The Reſemblance of Children to their Parents may proceed from theſe plaſtic Natures which form the Viſage, according to the ſprightly Imaginations of the Mother. We believe that this Likeneſs is generally a reaſonable Foundation to attribute a Child to a Man, but that is not a Rule; the Cauſe, which is nothing but the Imagination that rules the Actions of the plaſtic Nature, ſhews a Child may reſemble a Man who is not his Father; that which is moſt ſurpriſing is, that Children ſometimes reſemble their Grandfathers whom their Mothers never ſaw, and their Fathers have no Reſemblance of; in this Caſe there is no other Reaſon to be given but the Idieas of plaſtic Natures. But we may ſay Children are like their Fathers and Mothers at the ſame time, in ſuch a manner that the Features of the Mother are more obſervable, then thoſe of the Father will not appear; but a Mother, who will be more intent upon her own Features than upon thoſe of others, will tranſmit them to her Child, who by that Means will reſemble his Grandfather. There were Phyſicians who advanced that Men might be formed without the Seed's being received by the Woman; we have nothing to do, ſay they, but heat them by the warmth of a Dunghill; but this is falſe: Thoſe who advanced this Opinion had neither Experience nor Reaſon on their ſide; as the Egg is never fertile without the Help of the human Seed, we never can demonſtrate that the Semen can produce any Effect while it is not in the Reſervoir that Nature deſtin'd for it: If the Heat of the Dunghill could unfold the Embryo, could not the natural Heat unfold it better in Men who retain their Seed a long Time? It would follow hence that a Man would at laſt find himſelf with Child. I know they have told us ſome Stories thereupon; but thoſe are Tales an Anatomiſt will never believe, but by ocular Demonſtration, or unleſs authentic Witneſſes aver it. Some in their Writings have ſaid that young Women have conceiv'd without the approach of the Male; but this is alſo to be rejected. It is unneceſſary to refute ſuch Opinions.

1*ſt*, The Bones of the Cranium are very different, in the firſt Months they are only membranous; their middle is the firſt part that begins to oſſify, becauſe the Arteries advancing towards the Centre of the Bone become extremely ſmall; on the account of their Smallneſs they are ſtopped by Degrees by the white Subſtance of the Blood which is there congeal'd; the Cellules which are in the bony Subſtance at the ſide of the Veſſels, and are alſo filled with that white Subſtance which is there depoſited in Filtres, in ſwelling by Degrees diminiſh the Diameter of the Veſſels, that hence being ſtraitened, retain the cerous part, which not being able to circulate any more in the ſtraiten'd Veſſels congeal there entirely, and form an hard Subſtance; in a Word, the laſt Parts that oſſify are the laſt Veſſels which terminate in a Point, and become hard to form the Sutures. Some are of Opinion that it is performed in the following manner. It proceeds from the Veſſels of the Brain, which paſſing between the Bones of the Cranium, when they are arrived at the external Surface, do not continue their Way in a direct Line, but are forced on the Convexity of the Head; when forced they are ſupported againſt the Parts of Bones, on which they advance; theſe Parts which are below can't advance againſt theſe Veſſels, but thoſe that are between them find no Obſtacle, and therefore may lengthen into a Point; this is the Origin of Sutures. This Explication is mechanic, but appears not ſolid enough; it ſeems that theſe Sutures have already been formed by the Cauſe that faſhion'd the Bones otherwiſe; beſides, by the ſame Reaſon the Sutures ſhould be in the inferior Parts as well as ſuperior.

2*dly*, The bony Duct of the Ear has no Depth in the Fœtus, it is but a little Circle, the Bone advances afterwards by enlarging; we ſee no particular Cauſe in this, which is different from that which gives Accretion to the Bones.

3*dly*, The Teeth appear not, they are generally concealed under the Gums; *Vide* Number 52. 1*ſt*, We immediately find thoſe which appear the firſt, and which ſhed laſt. 2*dly*, Under theſe we find others that are the Buds of the ſecond, and occaſion the ſhedding of the firſt by their continual puſhing them forwards: The Teeth have their Veſſels that enter thro' their Roots, and when the Blood doth not circulate there, and reſts in the Body of the Tooth, then the internal Part grows carious. 3*dly*, The cutting of Teeth muſt give the Infant a great deal of Pain, ſince it muſt pierce the Gum and enlarge the Socket.

4*thly*, The Fœtus reſpires not, however ſome Authors have oppoſed it; *Hippocrates* ſays, the Fœtus pumps Air through the Noſtrils and Mouth. The great Mr. *Boyle* brought ſome Proof to ſupport a part of this Opinion at leaſt. The Fœtus, properly ſpeaking, reſpires not according to his Opinion; nevertheleſs, ſays he, as it appears by our Experiments, that all the Fluids contain Air, it will not be an abſurd Opinion to believe, that the Fœtus being ſomewhat grown reſpires a little, ſince the ſuperior part of the Amnios is emptied of its Fluid, and is only filled with a vaporous Fluid. He proves it by the Cries of the Child which is as yet in the Womb, and by the Noiſe of the young Chickens which the Hen has not hatch'd. Monſieur *Spon* was perſuaded by theſe ſame Reaſons, that the Fœtus reſpires in the laſt Months, but without any great Action of the Muſcles of the Thorax; the following are a few Reaſons to prove that there is no Reſpiration in the Fœtus before its entrance into the World. 1*ſt*, The Diaphragm is extraordinarily arched. 2*dly*, The Lobes are flatten'd and rais'd towards the external Part. 3*dly*, As ſoon as the Lungs have reſpired they ſwim on the Surface of the Water, and take a veſicular Form. But 4*thly*, When they have not reſpired, they fall to the Bottom when put in Water, and have not the Colour which the Air gives them when it has entered. 5*thly*, If there were any Air in the Lungs of the Fœtus they would ſwell when put in the Air Pump; nevertheleſs this happens not, be what Exactneſs ſoever taken in pumping of the Air when they are taken out of that Machine they fall to the Bottom as before. 6*thly*, In a Word, it is impoſſible that Reſpiration ſhould be performed with the little Quantity of Air that is found in the Uterus. 7*thly*, That which was advanced about the Cries of the Fœtus before it appears, is abſolutely fabulous, the moſt that could be heard were Grumblings cauſed by the Motions of the Waters, Air of the Vagina or Inteſtines; what was ſaid concerning the young Chickens is no leſs falſe, we never hear them but when the Shell is broke. 8*thly*, Some Authors aſſerted that the Placenta performed the Duty of the Lungs, and by its Means, the Mother furniſhed the Fœtus with Air neceſſary for Life. We cannot deny that there paſſes a little Air from the Mother to the Child, but doth that prove Reſpiration in the Child itſelf? *Bergerus* ſays, that the Fœtus has no need of Air to counterbalance the Preſſure of that which the Mother is environ'd with, becauſe it receives from the Mother a Portion of Lymph very much rarefied, which is enough agitated by the Æther. 9*thly*, The Motion of the Blood is very ſlow; in Dogs that are yet encloſed in theſe Waters we ſcarce feel the Pulſation of the Heart, but when the Animals have once reſpired, the reciprocal Motions of the Thorax make the Blood flow with Rapidity.

5*thly*, The Blood circulates in the Heart of a Fœtus differently from that in an Adult; there have been two Opinions thereon that have made a great Buſtle. The Opinion generally received was 1*ſt*, That the Blood of the Vena Cava that entered into the right Auricle paſſed in part into the right Ventricle, that from this Ventricle it was propel'd during the Contraction of the Heart into the pulmonary Artery: as the Veſſels of the Lungs inoſculate in the Fœtus, and that the Thorax and Diaphragm compreſs them, the Blood can't paſs there but in very little Quantities, it is therefore neceſſary that the Blood ſhould ſtop, if it had no other Paſſage, but Nature has taken care of that Inconvenience; ſhe formed a Duct which ſprings from the pulmonary Artery to the Aorta, the Blood therefore not being able to paſs freely into the Lungs is thrown into this Duct; we ſee nevertheleſs as the Blood of the Aorta reſiſts a little againſt the Entry of the Blood which is in that Duct, the pulmonary Artery will neceſſarily ſwell and become thicker than the Vein. After having conducted the Blood through the right Ventricle, let us return to the right Auricle. The Auricles are two Bags placed one over againſt the other; in the Partition that ſeparates their Cavity we ſee a Hole that forms a Communication with theſe two Bags, in that Hole we muſt obſerve a ſuperior and inferior Arch; the ſuperior forms a ſort of Croiſſant in the right Auricle; from the Lips of the inferior riſe two Membranes, one on each ſide; the Membrane of the right ſide enters into the left Bag, united with that of the right ſide it forms a Croiſſant, whoſe Points fix at the ſides of the Hole; this Croiſſant at firſt cloſes but a part of the Hole, at laſt it raiſes and ſlides, if we may ſo ſay, as a Saſh on the middle Partition of the two Bags, at laſt it is found two Fingers breadth above the Hole; but there are no other but theſe Points that are fixed, that which is between them both form a ſort of Bag ſowed up at one End; there even is often a ſmall Opening that communicates from the right Bag in the left. The Blood that comes in the right Auricle divides, one part enters, as we have ſaid, into the right Ventricle, the other paſſes through the Hole that communicates in the left Auricle, from thence the Blood circulates in the right Ventricle, and is thrown into the Aorta; theſe two Holes muſt of Neceſſity have exiſted for two Reaſons. 1*ſt*, All the Blood would have had a great deal of Difficulty to paſs through the arterial Canal, and would have too much dilated the pulmonary Artery. 2*dly*, Without this the left Ventricle would ſcarce have received any Blood, and ſo could not have dilated enough, when the Blood would have paſſed through the Lungs; I ſay the ſame of the beginning of the Aorta.

They were going to eſtabliſh an Opinion contrary to this: it was thought that the Blood which paſſes from the right Ventricle into the pulmonary Artery paſs'd through the Lungs, returned by the left Auricle, entered partly into the right through the *Foramen Ovale*, and partly into the left Ventricle; this Opinion is not well grounded. 1*ſt*, We ſee the Membrane that ſprings from the right ſide of the Hole enters into the left Auricle, and forms a kind of Flat, inclined to receive the Blood of the right Auricle. 2*dly*, When we blow from the right Auricle into the left, the Membrane ſhuts the Hole, and hinders the Air from returning. 3*dly*, We ſee no uſe for this Circulation.

From the time that the Air has entered the Lungs the Veſſels that were ſhrunk lengthen; their Compreſſion is leſs, becauſe the bronchial Veſſels being ſwoln leave a Space between them: The ſanguinary Ducts that are in the Interſtices may then receive the Blood more eaſily; Expiration which follows Inſpiration preſſes the Veſſels, and expreſſes the Fluids in the left Auricle; the Blood that ſwells this Auricle puſhes the Valve againſt the Hole, juſt as the Air which is there ſhut up in blowing; this Valve riſes by Degrees and lies cloſe to the Circumference of the Hole.

Two Queſtions might be here aſked. 1*ſt*, Why the Membrane or little Valve ſlips over the Hole? 2*dly*, Why the Part anſwering the Circumference of the Hole lies cloſe there? To the firſt I anſwer, that the Membrane grows, and by its growth it acquires Extenſion enough to cover the

Hole; we can give no other Explication to this Phænomenon, for we don't ſee that this Membrane is drawn by ſome Cauſe towards the ſuperior part of the Hole. As for the ſecond Queſtion, the Membrane lies not always entirely cloſe to the Circumference of the Hole, there often remains a ſmall Paſſage; it was ſaid, that the Blood puſhing againſt that Valve laid it cloſe to the Hole, but that is very uncertain.

6thly, The Liver is very large in a Fœtus; this proceeds from the Diaphragm's being immoveable, and therefore Inability of compreſſing it; but as ſoon as the Air has put this muſcular Partition in Motion immediately the Liver is compreſſed, the Blood cannot then ſwell that Viſcus as before. It is the want of Reſpiration that obliged Nature to form the venal Duct to ſhorten Circulation; if all the Blood were obliged to circalate through the Liver, there would have been a Difficulty for its Exit, becauſe there would not have been Force ſufficient to propel it; and thus this Viſcus would ſwell extraordinarily, and Nouriſhment could not have been ſent time enough to the Fœtus, beſides, a part of the nutritious and milky Juice would have been filtrated in the Liver: For all theſe Reaſons Nature has wiſely made a Canal in the Sinus of the Vena Porta, to tranſport the Blood immediately into the Vena Cava; when the umbilical Vein receives no more, the Vena Cava compreſſes the Canal, and at laſt ſhuts it.

7thly, The *Capſulæ Atrabilariæ* or the *Renes Succenturiales* are much larger in the Fœtus than in the Adult. *Valſalva* ſpeaks of a Diſcovery, which he pretends to have made thereon: This Anatomiſt ſays, he diſcovered a Veſſel that terminated in the Epidydimis of Men and Ovaria of

Women; we ought to wait till this be confirmed by ſome very eminent Anatomiſt. Could not *Valſalva* miſtake and take ſome little Nerve that runs that way for a Veſſel? As for the Reaſon of the ſwelling of theſe Capſulæ, we have obſerved nothing that could diſcover it.

8*thly*, After having ſeen the principal Differences in the Fœtus compared with the Adult, we muſt anſwer one Objection which might be rais'd againſt our Aſſertion of the Blood's paſſing in the Lungs as ſoon as the Fœtus reſpires; why, ſay they, flows it not always the ſame Way? 1*ſt*, When the tracheal Veſicles are ſwoln, the Veſſels that were contracted and ſhrunk extend; they cannot extend if there are not found empty Spaces, conſequently the Blood will be propel'd there by the ſame Reaſon that the Piſton re-enters the Syringe. 2*dly*, The Veſſels being no more ſtop'd, the Blood which is propel'd ſtraitly, will circulate, without turning about, through the ſides, as before; for the Force with which it entered in the lateral Duct is proportioned to the Reſiſtance which is found at the Entry of the Lungs. 3*dly*, In proportion as more Blood paſſes into the Lungs, there enters more in the Aorta; for the Aorta ſwell'd muſt compreſs the oblique Orifice of the arterial Canal; we ſee alſo that this Extremity is the firſt that ſhuts.

9*thly*, We may ſtill aſk why the Blood continues not paſſing into the Liver through the venal Duct? We may give almoſt the ſame Reaſon: The Diaphragm compreſſing the Liver, preſſes out the Blood and makes it re-enter the Vena Cava: the Veſſels that were extremely ſwoln will be then found empty, and thus in Expiration the Diaphragm riſing, the Blood will enter its Veſſels,

ſels, by the ſame Reaſons as the Air in the Air Pump, if a Hole is made in the Receiver; add to this, that the Blood that enters in a greater Quantity in the Vena Cava compreſſes the venal Duct, and hinders the Blood from entring there.

REMARK XXXVI. *Of the Situation of the Fœtus in the Womb.*

THE Fœtus is in the Womb as a Ball; that Figure is the occaſion of its taking up ſo little a Space, the ſame as the Poſition of the Head towards the Bottom, and of the Back againſt the *Vertebræ Lombariæ.* We have nothing to conſider but the Womb in its Cavity, and we ſhall ſee that this muſt be ſo; but as it has the Heels cloſe to the Buttocks, and the Knees to the Cheeks, the fixed Point on which the Body reſts is the Baſis, for it is that which is the leaſt moveable; according to this Principle, the Head which advances more than the Knees ought to carry the Balance, when violent Motions happen in the Fœtus; thus it will generally look downwards in the time of Labour.

REMARK XXXVII. *Of Lying in.*

THE firſt Thing we are to look into is the Cauſe which obliges the Fœtus to attempt an Exit. It was ſaid firſt, That it was the want of Nouriſhment that occaſioned the Fœtus's exit. But *Hippocrates*, who was Author or Defender of that Opinion, advanced this Sentiment without any Foundation; the Mother who nouriſhes ſo often two Fœtus's, can ſhe want Nouriſhment for one at the end of nine Months? Beſides, when ſhe is brought to Bed ſhe has more Milk than would nouriſh a Fœtus; could not this Milk ſuffice for the Nouriſhment before the Lying in? 2*dly*, It was ſaid that the Infant looſened itſelf from the Womb, for the ſame Reaſon that ripe Fruits looſen themſelves from the Tree; but then to ſuſtain this Compariſon it is neceſſary that the Roots of the Placenta ſhould dry in the ſame manner as the Stalk of Fruits; nevertheleſs this is not ſo, on the contrary, the Placenta, which is perfectly nouriſhed, is faſten'd at the laſt perhaps better than at firſt. 3*dly*, It was advanced that the Sharpneſs of the Fluids encloſed in the Amnios obliged the Infant to move and ſeek its Exit: But theſe Waters have no Sharpneſs, they incommode the Fœtus no more than Water incommodes the Fiſh; when the Fœtus is born, there is nothing found in this Water but what is inſipid. 4*thly*, The Weakneſs of all theſe Reaſons made us look into other Cauſes which might give the Fœtus room for Motion. As ſoon as the Urine and Excrements, ſays a celebrated Author, form a certain Maſs, their Sharpneſs, which incommodes the Fœtus as much as their Weight, obliges it to move; by theſe Motions the Head is turned on the ſide of the Orifice of the Womb, the Face generally is towards the Coccyx, in this Situation the Inteſtines and Bladder which are ſtimulated by the Urine and Excrements ſtill cauſe more Inquietude to the Fœtus, and therefore it attempts more to gain its Liberty; then it deſcends, and cauſes a Teneſmus in the Mother, this Irritation in her makes the Muſcles of the Abdomen act, which puſh the Fœtus into the Baſon; this Action of the Mother ſtill augments the Teneſmus, and by Conſequence the Efforts; the Force of all theſe Motions opens the Womb, which is relaxed by the Fluid that ſpreads and moiſtens it; the Water of the Amnios and Allantois ruſhes through the Rupture of the compreſſed Membranes; at laſt the Head of the Fœtus preſents itſelf to the Orifice of the Womb, the Action of the Mother puſhes it into the Vagina, which is rendered ſlippery by the Humour that iſſues from the mucilaginous and ſebaceous Lacunæ; the Navel String, the Membranes, the Placenta follow the Fœtus, and generally their Exit is attended by an Hæmorrhage. This Sentiment was advanced by *Courvée*, and ſuſtained by *Drelincourt*; the latter ſaid, that the Stomach and Inteſtines being filled with Meconium, a Cholick muſt certainly trouble the Fœtus: Theſe Pains, ſays *Drelincourt*, move the Fœtus, and make it ſeek its Exit from the Womb; but the Quantity of the Meconium is never ſo great as this Author pretends, it is moſtly the Stomach or the *Inteſtine Cæcum* where this fæcal Matter is found; hence perhaps is occaſion'd the Largeneſs of the Cæcum. As there is no Reſpiration in the Fœtus, the Colon which is not preſs'd will not empty itſelf, and thus the fæcal Matter will be accumulated at the Exit of the *Inteſtine Ileon*, and conſequently the Cæcum will be obliged to ſwell. 5*thly*, *Pechlin* and *Bohn* were not ſatisfied with this Opinion; they believed it was better to explain the Phænomenon which we ſpeak of in ſaying, that the Fœtus attempting to reſpire made it turn towards the Orifice of the Womb; but it is neceſſary theſe Gentlemen explain why the Fœtus would reſpire, ſince there is no need of it. *6thly*, *Bergerus* believes that the troubleſome Situation the Fœtus is found in is the Cauſe of its turning and changing its Place. The Fœtus, ſays he, is, if we may ſo ſay, ſeated in the Womb, it is crooked and forms a Ball to take up leſs room; when its Head is at the ſuperior Part, and its Back towards the Lumbal Vertebræ of the Mother, and the Elbows applied to the Armpits, it is ſo heaped up that the Knees touch the Eyes; the Noſe is ſeen between the Points which are placed on the Knees, the Legs are bent in ſuch a manner that the Heels are very near the Buttocks; in this Form, when it is come to a certain Growth, this Crookedneſs troubles it and makes it turn to take another Situation leſs troubleſome; during the Motions made for that Purpoſe, the Head turns towards the Orifice of the Womb. We may aſk *Bergerus* whence it comes in general that the Fœtus is not well ſenſible of this troubleſome Situation which it is found in at the end of nine Months exactly; nothing of Solidity can be anſwered to this. *7thly*, There was a celebrated Phyſician who ſtill aſſign'd a Cauſe more mechanic. The Menſes, ſays he, flow not exactly every Month but with relation to the Plethora; as ſoon as the Woman is with Child, the Blood that formed the Plethora ſends a Milk to the Child; nevertheleſs there always is a little that accumulates and ſwells the Veſſels, but cannot overcome their Reſiſtance; at laſt at the end of nine Months there meets a Quantity large enough to iſſue out through the membranous Ducts of the Womb; that Blood can't ruſh out without looſening the Roots of the Placenta which bar its Paſſage; by the diverſe Motions which the Womb then ſuffers is the Fœtus agitated, this Agitation cauſes it to move, in theſe Motions it turns downwards, a Teneſmus ſucceeds theſe Motions, *&c.* the Mother at thoſe times perceives a Pain in the Loins; the Inteſtinum Rectum, and the Bladder, by the Compreſſion of the Womb, with great Difficulty permit the Excrements or Urine to paſs; the Fœtus always moving breaks the Membranes which ſurround it, the Orifice of the Womb, which was ſhut and pretty exactly cloſed by the glutinous Humour of which we have been ſpeaking, opens, that Humour comes firſt, and then follow the Waters of the Amnios that moiſten the Orifice of the Uterus, which being irritated is bound up, and propels its Contents towards its Orifice; the Waters flowing, the Fœtus is ſtraiten'd. This Preſſure cauſes diverſe Motions in it, then by theſe diverſe Shakings it ſtill agitates the Womb; theſe reciprocal Agitations, and the Enlargement of the Orifice of the Womb, cauſe a great many Pains in the Mother, eſpecially at the Navel, Arm-pits and Loins, whence they anſwer to the Parts of Generation; hence we ſee there muſt happen great Changes in the Pulſe, Heat, Circulation of the Blood, *&c.* at laſt by theſe Efforts of the Infant whom the Mother puſhes with the Diaphragm and Muſcles of the Abdomen, the Womb is diſcharged of its Load.

Harvey advanced that the Fluid ſhould not expand during the Labour; he regards as natural Births only thoſe in which the Infants make their Exit wrap'd up in their Membranes; and thoſe wherein the Infant comes out ſtrip'd of all the Teguments that encloſed it, appear to him contrary to the common Courſe of Nature; but then it would hence follow that there would be no natural Births, there are few Fœtus's that do not tear their Coverings; beſides, we ſee here the Induſtry of Nature, which makes the ſame Thing ſerve many, the Waters of the Amnios that are neceſſary for the Fœtus ſerve to relax the Texture of the Womb that it might launch out the eaſier.

Parée ſaid, that the Os Pubis ſeparated one from the other in the time of Delivery; ſeveral Anatomiſts were of the ſame Opinion, but what made them ſo was more their Credulity than Obſervation. How is it poſſible that the Oſſa Pubis which are ſo ſtrongly united ſhould ſeparate? We need but examine their Symphiſis to demonſtrate that this cannot be ſo: But then they will ſay there have been Women between whoſe Oſſa Pubis they could have thruſt their Fingers; if there were a Cavity found, and at the Sides were perceived a bony Reſiſtance, it would be of ſome weight, but if there was only preciſely found a Cavity we can conclude nothing; this may be thus found by the ſwelling of the lateral Parts: Beſides, the ſame Cauſe which ought to ſeparate the Oſſa Pubis keeps them in their Place, for a Pillar of the external Oblique on the right ſide that is inſerted into the Os Pubis on the left, and the Pillar of the left ſide is inſerted into the Os Pubis of the right ſide; when theſe two Muſcles act, they approach the Os Pubis one near the other: I don't deny that there have been Caſes where the Oſſa Pubis have ſeparated, but that has been rare.

The Membranes, the Navel String come after the Fœtus; they are called After-births, becauſe it is a ſort of ſecond Delivery; it happens ſometimes that the Fœtus comes into the World covered with its Amnios, this Covering gave room to many chimerical Ideas, of the Welfare of which this was regarded as a Preſage among the Vulgar.

When the Womb is freed of its Load there enſues an Hæmorrhage mixed with a ſerous Humour; we ſhould not be ſurpriſed that this is ſo, the Veſſels of the Womb were extraordinarily dilated; as the Placenta was fixed to the Lacunæ it enlarged them in ſeparating and broke the Veſſels, the too much inflated Arteries hence diſcharge a part of their Blood; this Flux is in *Latin* called *Lochia*, and in *French Vuidanges*; at laſt the muſcular Fibres of the Womb are bound, and by their Contraction cloſe the Orifices which give a Paſſage to the Blood; this Contraction is made in a very ſhort time. *Deuventer* tells us, that having diſſected a Woman who had been brought to bed nine Days before, he found her Womb as cloſe as if ſhe had not been delivered; as for the Quantity of Blood it is leſs or more, according as the Placenta adhered with more or leſs Violence. *Salmuth* ſays, he ſaw a Woman whoſe *Lochia* did not flow, and the Blood that ſhe ſpilt in the time of her Lying in would not have been ſufficient enough to ſtain the Hand; this could not proceed but from the Placenta's ſeparating without wounding the Uterus by the Divulſion: this Caſe is very rare. An Obſervation was made not long ago, by which it was proved, that it is Contraction that cloſes the open Veſſels; for if we tickle the Part above the Oſſa Pubis, the Blood ſtops, for this Tickling doth nothing but help this Contraction.

There have been Authors who pretended that the Partitions of the Womb became much thinner; really this in effect ſeems to happen immediately, for the Partitions in extending ſeem to loſe ſomething of their Thickneſs. This was certainly the Reaſon why *Galen*, *Vezalius*, *Falconburg*, and *Moriceau* were of that Opinion, but *Bohn* and *Deuventer* demonſtrated to the contrary; when we attend a little we ſee it cannot happen otherwiſe: if the Womb is much extended, the ſpongeous Texture is in like manner inflated by the Veſſels that are there found expanded, and very much diſtended.

Harvey propoſed a Problem which is not eaſy to be reſolved; he aſks how it is poſſible that a Fœtus, come into the World with its Coverings of the Womb, can live long enough ſhut up in theſe Waters? and why it dies (when it has once reſpired) if Breath fails it? 1*ſt*, Some have anſwered, that the Blood circulates no more thro' the *Foramen Ovale* as ſoon as the Fœtus has reſpired; if this were ſo, it is evident that as ſoon as the Fœtus received Air in the Lungs it could have no more Life when it reſpir'd not. *Kerkering* ſeems to confirm this Idea, when he ſays, that the *Foramen Ovale* is cloſed in the Fœtus reſpiring, by means of its Valvule; for the Blood returning from the Lungs fills the left Auricle and applies the Valve to the Hole; but if we examine this Anſwer with Attention, we ſhall ſee it cannot ſatisfy the exact Enquirer. 1*ſt*, Experience teaches us that the *Foramen Ovale* doth not cloſe ſo ſoon, the Opening is ſeen ſometimes three or four Months after; there have been Subjects of grown Perſons who had their *Foramen Ovale* open. 2*dly*, In Inſpiration the Blood enters into the Lungs and goes out by Expiration; according to this Opinion, when the Child wants Air, the Blood cannot circulate in the Lungs, ſince Inſpiration cannot be performed; theſe Lungs emptied tranſmitted their Blood to the left Auricle, which propel'd it into the left Ventricle, thence it returns again in the right Auricle by the Vena Cava: Why can't this Blood paſs through the *Foramen Ovale*, as when in the Womb of the Mother? 3*dly*, The only Difference found in the Circulation of the Blood of a Fœtus, is that it is obliged to paſs in the inferior Parts in larger Quantities, but this Difference cannot hinder the Circulation through the *Foramen Ovale.* 4*thly*, *Bergerus* ſays, that the Fœtus is not expoſed to the Preſſure of the Air when it is in the Womb of the Mother, and in its Waters; but if the Air touches it not immediately, it preſſes it as much by the Means of the Membranes and Water, therefore this Reaſon is not ſufficient: Beſides, in caſe the Air ſhould compreſs the Fœtus more out of its Membranes, I don't ſee that this ought to hinder Circulation through the *Foramen Ovale*; on the contrary, the Air in preſſing the Thorax ſhould reduce the Lungs to a ſmall Extent, the ſame as before Reſpiration, therefore every thing would be found in the Situation which was neceſſary for the circulating of the Blood as before its Birth. 5*thly*, I know not how *Harvey* made his Experiment, perhaps he put a Fœtus juſt born in an Air Pump: If this was the Caſe, it would not be ſurpriſing that Death followed the Privation of the Air, for then all the Machine is diſordered by the Defect of the Equilibrium, which is found between the internal and external Air. If *Harvey* ſtopt the Reſpiration of any Fœtus, and did it either in Inſpiration or Expiration; if in Inſpiration, we ſee that the Air being ſtopt in the Lungs will not permit the Blood to circulate, ſince it will with Vehemence enter the Lungs without being propel'd there; if during Expiration, I ſee not how this Phænomenon may be explained. Perhaps we may ſay that the Air, which is always in the Lungs, rarefies it ſo ſtrongly by its Heat, that it kills the Fœtus: an Author mentions an Example of a Soldier who found a Womb in the Water, which encloſed a Fœtus ſtill living.

REMARK XXXVIII. *Of the Thorax.*

THE Thorax is a Caſe whoſe ſolid Parts are the Spine, Sternum, Ribs and Cartilages; the Spine is a fixed Point on which the Extremities of the Ribs turn to augment the Cavity of the Breaſt; we will hereafter explain how this Dilatation is performed: I will give here nothing but a general Idea of the Situation of the Parts contained in the Breaſt. From the Mouth there deſcends a pretty large Duct, which immediately divides into two Branches, which ſubdivide into an Infinity of others; at the Bottom of theſe ſmall Twigs are found Veſicles that reſemble Grapes; the heaping together of theſe Veſicles forms a Wing on each ſide, and theſe are called Lobes; they take up all the Cavity of the Thorax. Between theſe two Wings at the anterior and inferior part we ſee the Heart, to which, if we may ſo ſay, the left Lobe gives a Paſſage through a Groove, ſo that in the Pulſation of the Heart the Lungs may not be offended; the Heart which is fixed by the Veſſels that it ſends to the Lungs, is encloſed in a Bag called *Pericardium*; this Bag is faſtened to the Diaphragm, which is the Partition that ſeparates the Thorax from the Abdomen; behind the Ducts, whence hang the Lungs, deſcends the Œſophagus; we will give the Reaſon, or rather Neceſſity of this Situation. The Cavity which receives all theſe Parts can grow broader by the Motion of the Ribs, it is lined with a Membrane, the which being come to the Sternum adheres to it; after having been faſtened there it runs towards the Spine; thus it forms two Lodgments, the one for the right Lobe the other for the left: that middle Partition is called Mediaſtinum; between theſe two Membranes at the inferior part is placed the Heart.

REMARK XXXIX. *Of the Mammæ.*

TO have an Idea of the Arrangement of all theſe Parts that we have juſt deſcribed, we muſt repreſent to our ſelves two Bags placed on the anterior, lateral and leſſer part of the Thorax; theſe Bags have common Teguments and proper ones, the common are thoſe that cover them anteriourly, and are a Continuation of common Teguments of the Body; under theſe Teguments are the two Bags, of which we have been ſpeaking. An Author was of Opinion that they were covered by two Membranes, the one internal the other external. The internal, ſays he, communicates in ſuch a manner with the Glands and Fibres, that it cannot be ſeparated without tearing the Subſtance of the Breaſts: I have not obſerved this Duplicature in the proper Teguments of the mammillary Bags. After theſe Teguments appears the Fat which covers the Subſtance of the Breaſts, which owes its Origin to the following Veſſels, whoſe Courſe we ſhall immediately deſcribe. The Arteries proceed from the Axillaries and Subclavians that communicate with the Epigaſtrics; after having formed many Circumvolutions, they ſend ſmall milky Ducts, which are this white Matter that is found when the Breaſt is laid open; there are Veins that carry back the remaining Blood, after the Milk has entered the ſecretory Ducts: we have mentioned it before; the Origin of the Nerves we ſee in *Heiſter*.

Wharton imagines that there are ſtill others which riſe from other Places. He gives us the Hiſtory of a Girl aged fourteen who was very lean: The fleſhy part of the Breaſts, ſays he, was conſumed, but the Nerves were ſo numerous, that we could almoſt ſay there was nothing elſe; they reſiſted againſt the Knife as a Bladder, or as Braſs, but the milky Ducts that are of a membranous Subſtance might cauſe this Reſiſtance; in a Word, to follow the Courſe of the Veſſels, their Extremities tranſmit the Milk into Strainers, whence run Ducts that communicate between themſelves, Space between Space; theſe Ducts run and thicken to contain more Milk; at laſt approaching the Nipple, about which we ſee a Circle that is covered with ſebaceous Lacunæ, from which there has been ſometimes preſs'd Milk, they form ſtraiter Ducts, accompanied with fleſhy and nervous Fibres, that form the Nipples; theſe Ducts have no determined Number, and communicate by diverſe Inoſculations before they run out; their Extremities are mixed with many nervous Papillæ.

This is the Structure of the Breaſts; Nature has not freed thoſe Parts from her *Luſus.* Women generally have but two Breaſts; but *Blaſius* has remarked three in one Woman; *Walœrus* and *Borrichius* obſerved the ſame. *Thomas Bartholin* gives an account of a Woman that had four; another Anatomiſt has made the ſame Obſervation: as for their Bulk they are monſtrous in ſome Countries; at the Cape of *Good Hope* the Women have their Breaſts ſo long that they throw them over their Shoulders.

After having ſeen the Structure of the Breaſts, we muſt mention ſomething of their Uſe, which is to ſeparate the Milk from the Maſs of Blood. The firſt Queſtion to be examined is the Nature of the Milk that flows from the Breaſts. 1*ſt*, Here is what is diſcovered by the Help of a Microſcope. I fain would examine, ſays *Lewenhoek*, what Matter the Blood is formed from, and I obſerved that it is compoſed of ſmall red Globules that ſwim in a clear Fluid. I alſo diſcovered that the Milk was nothing but a Cluſter of ſmall

Globules that ſwam in a diaphanous Fluid; but the Globules of the Blood differ from thoſe of the Milk in their being of an equal Bigneſs, while thoſe of the Milk are ſome ſmall, others large, of irregular and ſomewhat globular Figure.

By the Analyſis we thought to diſcover the Nature of Milk, but we by that ſhall never gain the Point. Fire changes Matters, ſince it diſcompoſes them, it cannot therefore give us the true Principals of Bodies; thoſe who reaſon on the Nature of Milk, according to the Analyſis, have no more Reaſon than thoſe who would know the natural State of Pebbles by Lime. It will be then aſked whether the Milk is acid or alkaly? It is neither the one nor the other; the acid Salts that are ſeparated from the Aliments are inſinuated in the animal and vegetable Earths, or rather in their Alkalies; in this Mixture it cannot have an Acid or Alkaly, a middling Salt will be only produced; add to this that Oil changes theſe Salts vaſtly.

Milk is nothing but a true Chyle, but has a leſs Serum; it is ſomewhat more triturated by the Heat of the Blood, Motion of the Heart, and Reſſort of the Veſſels: Cheeſe, Cream and Butter may be made of it; it coagulates not on the Fire as the Serum of the Blood; that only which exhales leaves a thickiſh Subſtance at the Bottom. 1*ſt*, It has a leſs Serum, becauſe that which is found in the Chyle divides into the whole Maſs of the Blood; it muſt therefore have but a part of it in the Milk. 2*dly*, The Milk was more triturated ſince it paſſed the Heart and moſt of the Veſſels. 3*dly*, We may make Cheeſe of it, which we cannot do in the Chyle, becauſe the Oil is not ſeparated enough from the Phlegm and mixed with the Matter that forms the Baſis of the Salt of the Blood. 4*thly*, It coagulates not as the Serum of the Blood, becauſe that has paſſed thro many Strainers; when it has paſſed through theſe Strainers, the moſt aqueous part flows into the Filtres and lymphatic Veſſels, the oily part therefore gathers in greater Quantity, then it mixes not ſo well with the Water: If expoſed on the Fire what happens? The Parts of the Fire act on theſe oily Parts concenter'd, their Action expreſſes the Water that remained there, the oily Parts therefore muſt gather together and form a more ſolid Whole; the ſame happens not to the Chyle, becauſe the Oil was not concenter'd enough in paſſing through the Strainers and natural Heat. *5thly*, Milk alkaliſes in Fevers, it changes Colour, it has been ſometimes obſerved to become yellow from Night till the next Day; this Colour is given the Milk when we boil it with Alkalies: The Heat that is excited in the Blood by Fevers produces the ſame Effect; thus we ſee that animal Subſtances are leſs proper to afford good Milk than vegetable Subſtances; for the Parts of Animals are more alkaliſed and diſpoſed to Putrefaction.

The ſecond Queſtion to be examined is, whether the Milk comes from the Blood immediately, or whether it be nothing but a Chyle brought to the Breaſts by particular Ways. The Ancients ſaid, that it in ſome meaſure proceeded from the menſtrual Blood. *Coringius* advanced that it was produced by the Blood that became not perfectly red. *Barbatus* believed that it proceeded from the Serum of the Blood. *Malpighi* ſaid that Fat could produce Milk. *Entius*, *Deuſingius* and *Everard* form it from the Chyle. *Wharton* is of the ſame Opinion, but he adds the nervous Juice to it.

The Ancients knew but the Arteries and Veins, and therefore ſought for no other Veſſels to carry the Milk to the Breaſts. The Knowledge which they wanted, ſays *Needham*, hindered them from erring; but after *Aſſellius*'s Diſcovery of the lacteal Veins, they began to ſeek for Canals that might immediately carry the Chyle into the Breaſts. *Everard* ſays, that having diſſected a Bitch which was with young and gave ſuck, he obſerved chylous Canals that crept by the Muſcles of the Abdomen upon the Fat, and were inſerted in the glandular Texture of the Breaſt; but this Diſcovery was not confirmed by any Anatomiſt; there is therefore more appearance that there are no milky Canals, and that the Chyle comes from the Blood in the Breaſts; the Ducts are not neceſſary, for the Chyle may be carried through the ſanguinary Veſſels. 1*ſt*, We have ſeen Examples that prove the Milk may iſſue out through an infinite Number of Places, as through the Thigh, *&c.* it is certain therefore that nothing can carry that milky Juice there but the Blood. 2*dly*, Injections prove that there is a continued Way from the Arteries to the milky Ducts; this Continuation of Canals can be of no other uſe than the diſcharging the Arteries. 3*dly*, What could be objected is, that the Blood might change the Chyle; but here follows a ſolid Anſwer taken from *Lower*. The Chyle, ſays he, mixed with the Blood leaves not its Whiteneſs immediately, on the contrary, it circulates a long time with the Blood before it loſes its Colour; we have nothing elſe to do but to open the Vein of an Animal four or five Hours after it has eat much, and we ſhall ſee a great deal of Chyle ſwimming on the coagulated Blood; this Chyle is like the Milk: I have made the ſame Experiment in Men that were bled after a full Dinner or Breakfaſt, the Veſſels rather ſeemed full of Milk than Blood. *Manget* obſerved a perfect clear Chyle come from the Noſe of a Man who had loſt a great Quantity of Blood in an Hæmorrhage.

The third Queſtion to be examined is, how the Milk filtrates and is ſuck'd by the Child? The Blood filled with Chyle is carried into the Arteries of the Breaſt; by the Mechaniſm of Secretions which we have already explained, the Blood is too thick to paſs through the Strainers, but the Milk, whoſe Mollicles are not ſo thick, according to *Lewenhoek*, immediately inſinuate there; from theſe Strainers iſſue out Lymphatics; by the Preſſure of the Blood and Membranes the aqueous Part is inſinuated, ſo that the Milk has leſs Phlegm: this Milk, carried into the Follicles and Ducts is propel'd by the Blood found in the ſpongeous Texture with which the milky Canals are environ'd, and of which the Nipple is formed. The Ducts that receive the filtrated Milk are very numerous, and grow wider towards their middle part, they can therefore contain a large Quantity of Fluid; when the Diſtenſion of the Veſſels will ſurmount the Oppreſſion of the Nipple, the Milk will flow voluntarily; the Mechaniſm by which the Infant cauſes the Milk to come to it is this. *Steno*, in his Treatiſe on the Glands, ſays, that Nature gave Nerves to the parotid Glands (which very much reſemble the glandular Bodies of the Breaſts) thus according to the Action of Imagination and Will, the Saliva may flow from its Reſervoirs; when the Nerves are about to act, ſays he, they ſtraiten the Veſſels through which the Saliva might flow, and oblige it to iſſue out. What *Steno* ſays of the Parotids on the Subject of Nerves may be ſaid of the Breaſts; they are covered by an infinite Number of nervous Fibres which form Papillæ on the Nipples, as obſerved by *Ruyſch*; theſe Papillæ being irritated by ſucking ſtraiten the capillary Veſſels that retake the Blood from the ſpongeous Texture; thus the Blood, which is always propel'd through the Arteries, accumulates there, and preſſes the milky Tubes, which by that Preſſure pour out the Milk. There is ſtill another Cauſe that obliges the Milk to iſſue out, the Infant pumps the Air in ſucking; thus the Milk ought to iſſue out with an Impetuoſity proportionable to the Force with which the Air is pumped. If by a ſudden Inſpiration all the Space of the Mouth were found void of Air, in ſuch a manner that that Fluid could not enter there any other way, the Milk would run with a great deal of Force, as we may ſee when we ſuck a Fluid with a Tube; then the Lacteals are extremely preſs'd by their Number at the Places where their Inoſculations are found with the external Ducts, and by that Preſſure ſtopt the Paſſage of the Milk; theſe Veſſels, I ſay, compreſs'd by the Force of the external Air, throw the Milk into the Infant's Mouth.

The fourth Queſtion to be aſked is, why Men have not Breaſts? We may anſwer to this, that they are of no Uſe to them: Nature immediately formed the Parts that were neceſſary for the Conſervation of the Species; tho' theſe Parts are unuſeful in one Sex, ſtill that Sex is not entirely depriv'd of them, unleſs that Deprivation be a neceſſary Conſequence of the Structure that makes the Sexes to differ. If what Travellers ſay, that Men nouriſh their own Children be true, we could not then ſay that the Breaſts were entirely unuſeful. *Venetius* gives us an Example of a Man whoſe Breaſts contained a vaſt Quantity of Milk. *Theophilus Bonetius*, in p. 163 of his *Sepulchretum Anatomicum* gives us many of the like Stories. The Men, of whom theſe Authors ſpeak, might without doubt nouriſh an Infant, if their Breaſts were ſuck'd: but it will be ſaid, why have not Men Milk as well as Women? *Nathaniel Highmor* anſwers, That the glandular Bodies which are found in the Breaſts of Women, are not found in thoſe of Men; or that they there appear dry; the Breaſts, ſays he, are very prominent, in fat and effeminate Men, but their Figure and Subſtance diſtinguiſh them from thoſe of Women. *Ariſtotle*, with Reaſon, ſays, that the Subſtance of the Breaſts of Women is fungous, and that it was depreſs'd and dry in thoſe of Men. Theſe Reaſons of *Ariſtotle* and *Highmor* go not to the primary Cauſe; it would be neceſſary that they explain why the Breaſts are more dry in Men than Women. 1*ſt*, In Infants of either Sex the Breaſts are very much inflated, and generally contain ſome Milk; it muſt be ſo ſince the Organs are the ſame, and that there is no more Tranſpiration on one ſide than in the other, while the Fœtus is in the Womb of the Mother, and during its Infancy. 2*dly*, As ſoon as young Women are arrived to a certain Age, and that they have their Menſes, then the Veſſels of the Breaſts, which are very flexible, dilate; from theſe Veſſels there always paſſes a Fluid in the lacteal Follicles; the turgid Arteries alone can't produce the Tumour that riſes there, and this Fluid repaſſes in the Veins or Arteries; perhaps we may ſuſtain that it is in the Arteries it runs back again; for theſe Canals being compreſſed by the Texture of the Breaſts which is very firm, and the reſſort of the ſmall Veſſels, the Fluid may return in the Arteries; but it is probable alſo there may be Canals to bring them back into the Veins. The Swelling we have been ſpeaking of happens in proportion as young Women approach the Age of thirteen or fourteen Years, then it is perceived, eſpecially ſome Days before the Menſtrua flow; the Blood that fills the uterine Veſſels in an extraordinary manner, hinders that which follows from entering the Blood which flows in greater Quantity into the Arteries, which from the Abdomen communicate with the Breaſts, and hence the Breaſts ſwell; as ſoon as the ſecretory Ducts of the Uterus begin to open, the Blood paſſes no more in ſo great a Quantity thro' the Arteries communicating with the Breaſts: The Blood that ſwelled the Breaſts circulates by Degrees, and the Fluid ſeparated from it, preſs'd by the mammillary Texture, re-enters the Courſe of Circulation by Degrees; the Breaſts muſt then be evacuated, as we have already ſaid. *3dly*, Thus we ſee that the ſame Reaſon, which proves no menſtrual Flux in Men, proves that the Milk ought not to filtrate in their Breaſts; as they have no Plethora, the mammillary Veſſels which are never ſwelled, do not dilate; on the contrary, as they fortify and harden, the Follicles and milky Ducts acquire a Hardneſs, becauſe they are membranous; and thus the Blood would not be able to ſeparate the Milk, when there ſhould even at laſt happen a Plethora, as we often ſee by periodic Fluxes which are performed thro' the hæmorrhoidal Veſſels. *4thly*, We may nevertheleſs ſee Men, in whom a Plethora, large mammillary Canals, a Preſſure or Sucking will produce Milk; all this depends upon the Dilatation of the Canals.

The fifth Queſtion worthy our notice is, why Women after Childbed have Milk? The Mechaniſm only of the Motion of the Parts in Childbed may anſwer this Queſtion; thoſe who were not of the ſame Opinion have ſaid nothing but Abſurdities. *Deuſingius* believed, that the menſtrual Blood contracted a certain Quality that rarefies the Blood, and there forms a Diſpoſition to change into Milk: He adds, that the Fœtus compreſſing the Pancreas and Stomach, propels the Chyle towards the Breaſts; but that laſt Reaſon would prove that the Milk ſhould be formed during the Pregnancy and terminate after Delivery. *Diemerbroek* not much ſatisfied with that Explication, ſays, it is nothing but Imagination that determines the Milk towards the Breaſts; he brings many Examples to prove that Opinion: but there is more Imagination in the Opinion of that Anatomiſt, than in the Cauſe that gives lying in Women their Milk. Likely, according to him, that Goats which have Milk, though they have not been with young, have a very great Force of Imagination, ſince they have it long before Women. *Bayle* Profeſſor of Philoſophy at *Toulouſe* is every where for Fermentations; he attributes the Origin of Milk to a Fermentation: I will not enter into the whole Explication which is unworthy of ſo great a Man, we may aſk his Followers, 1*ſt*, Whence proceeds this Fermentation? 2*dly*, How it is produced in the Breaſts? 3*dly*, What is its Nature? If they have but Poſſibilities or Imaginations they are not worthy to be heard.

To comprehend the Cauſe that propels the Milk into the Breaſts after Childbed, we muſt recall, 1*ſt*, That the Milk proceeds from the Chyle. 2*dly*, That the Veſſels of the Uterus are extremely dilated during Pregnancy. 3*dly*, That the Uterus retires immediately after Childbed. 4*thly*, That there paſſed a great Quantity of Chyle or milky Matter into the Fœtus. From the third Propoſition, 1*ſt*, it follows, that the Blood being no more able to enter in ſo great a Quantity into the deſcending Aorta, will mount in greater Quantity in the aſcending Arteries, and conſequently the Arteries that come from the Subclavian and Axillary in the Breaſts, will be more turgid. 2*dly*, It follows from that ſame Propoſition that the Blood which enters in the deſcending Aorta, being no more able to be inſinuated in ſo great a Quantity in the Uterus, will fill the epigaſtric Arteries more which communicate with the Breaſts; the Breaſts then muſt be more inflated on both ſides after Childbed. *3dly*, From the fourth Propoſition it follows, that the ſuperfluous Chyle of the Nouriſhment of the Mother, which paſſed in the Fœtus, muſt divide to flow in other Veſſels, and conſequently be carried to the Breaſts. At the firſt Circulation that will be performed, there will come one part; at the ſecond another *&c.* and at five or ſix Hours after eating, the Chyle is not yet changed into Blood, the numerous Circulations that will be performed during that time will there carry the greateſt part of that Chyle which would have paſſed in the Fœtus, if it were ſtill in the Womb of the Mother. Whilſt the Chyle is thus carried to the Breaſts the Follicles fill in an extraordinary manner, and the inflated Ducts are very much compreſſed; and at the Place where they inoſculate, this Preſſure hinders the Milk from overflowing; the Ducts that were not as yet open contribute alſo by their ſtreight Cavity to hinder this overflowing. But as ſoon as the Breaſts are once ſuck'd, 1*ſt*, The external Ducts dilate; 2*dly*, The Cylinders of Milk that are in the internal Ducts are contiguous with the Cylinders that entered the Externals, the Milk therefore which flowed not before, will ſpurt out after we have once ſuck'd theſe Ducts that were empty of Milk, by the ſame Reaſon that the Urethra is ſometimes empty of Urine through the too great Dilatation of the Bladder, which being too much inflated, thruſts its Neck again into its Cavity, as we have before explained it. *3dly*, By the ſame Reaſon that Milk is filtrated in the Breaſts of Lying in Women, it may alſo be filtrated in thoſe of Maidens whoſe Menſtrua are ſuppreſs'd; for the Blood not being able either to circulate freely, or to iſſue out through the Womb, will be propel'd in the Breaſts, as this often happens; hence we may ſee that this may happen to Women in Age, that have their Menſes no more; nevertheleſs as the Fibres are dried by Age, this will not happen in aged Women, whoſe Parts are dry.

The ſixth Queſtion to be aſked is, whence ariſe the different Proprieties obſerved in the Milk? 1*ſt*, The Milk grows ſour, which happens not to other Fluids that riſe from the Blood; this Sourneſs proceeds from nothing but from the Acids ſeparating from the alkaline Earth and their Oil, which happens not to the other Fluids, becauſe the Heat has more ſtrongly united their Principles, and diſpoſed them more to Alkaly than to Acid. 2*dly*, Milk has the Virtue, Taſte and Smell of the Aliments, becauſe the Parts of Matter with which we are nouriſhed paſs into the Blood without being diſcompoſed, and enter into the Breaſts without having ſuffered almoſt any Change, as it appears by the Experiment of *Lower*. Thus if the Aliment be good, the Milk will be good; if it is bad, the Milk will be ſo too, eſpecially if we have faſted; for then it cannot be mixed with any other Matter that might give it ſome Alteration. Some Hours after Meal, as it has circulated, it will be proper to form good Milk; if it was too acid, the Heat will then have changed it, and will be more diſpoſed to become alkaly; if it be too much alkaliſed, the alkaline or too much heated part will precipitate by the Urine, becauſe it becomes more viſcous, as we may ſee by the Urine; if a Nurſe faſts twenty four Hours the Chyle will alkalize, and thus will form a yellow, ſaltiſh Milk, diſpoſed to putrify.

REMARK XL. *Of the Parts that are below the Breaſts.*

WHEN we have raiſed the Breaſts we diſcover the great Pectoral Muſcles; altho' it be ſaid that they are of no Service to Reſpiration, becauſe the Ribs are moved by their Muſcles, they muſt of Neceſſity be attach'd to one Point; nevertheleſs the Sides are the Point the moſt fixed, they cannot therefore be raiſed by theſe Muſcles. As for the great Pectoral Muſcle we ſoon can prove it to be of no uſe in Reſpiration; let us but ſtrongly approach the Humerus on the forepart of the Breaſts, then the great Pectoral Muſcle will be in Contraction, and we ſhall ſee Reſpiration will be much more difficult. Reaſon confirms this Difficulty; the two pectoral Muſcles muſt be conſidered almoſt as a Cord, which placed below the two Armpits, it is evident that that Cord would hinder Reſpiration, ſince it would ſtraiten the Thorax, being drawn backwards.

The intercoſtal Muſcles are, properly ſpeaking, the Muſcles of Reſpiration, but their Action has been very much intangled by the various Opinions given thereupon; that which renders the Explication of their Uſe difficult is, 1*ſt*, That they are diſtinguiſhed into two Plans, the one internal, the other external. 2*dly*, That the Plans are oblique. 3*dly*, That the internal Plan is inclined there from the fore to the hindpart, the external Plan from the hind to the forepart. 4*thly*, That the external Plan comes no further than the Sternum, the internal Plan goes no further than the Spine; before we determine their Uſe we muſt talk of the Motion of the Ribs to which they are attach'd.

Borelli conſidered the Ribs as Hoops placed obliquely, ſupported behind by the Spine, and before by the Sternum. Theſe Hoops, ſays he, if they ariſe, will augment the tranſverſe Diameter of the Breaſt; but as the Ribs have a ſecret Spring, it is impoſſible they ſhould be preſs'd on their Convexity, and eſpecially towards the middle, that they might not puſh the Spine and Sternum; the Spine can't recoil, the Sternum will therefore only yield; by the Action of the Coſtæ it will riſe before, and conſequently the Breaſt will augment laterally and anteriourly, for the Ribs of the one ſide will be diſtant from thoſe of the other, and the Sternum will be diſtant in the ſame time from the Spine. We may have an Idea of this, in imagining that the Ribs make a Demicircle, bended and inclined upon a Wall, in ſuch a manner, that one of the Points on which it is ſupported is moveable: if we raiſe the Circle, and preſs the Circumference by the convex Part, it is evident that the Space which is between the Wall and the Circumference will augment, and that the moveable Point will recoil: Let us apply it to the Breaſt; the Plan which divides the Breaſt is the Wall; the Sternum the moveable Point; the Spine the immoveable; the Ribs are Demicircles inclined at bottom, they muſt therefore move in the ſame manner as the Demicircle of which we have been juſt now ſpeaking.

Bellini conſidered the Breaſt as a Bladder, whoſe Pleats form the Circumference, and are bent and inclined upon the Axis, as ſoon as the Bladder is empty; this is reduced to the Explication of *Borelli*.

Every thing perſuades us that the internal intercoſtal Muſcles ſerve to pull down the Ribs, and the external to raiſe them, and conſequently the one ſerves for Inſpiration, and the other for Expiration; theſe were the Reaſons that made *Bayle* advance this Opinion. 1*ſt*, Their Contraction muſt agitate the Part the moſt eaſy to move, for a longer Lever is moved eaſier, *cæteris paribus*, than a ſhorter Lever, conſequently the Part of one ſuperior Rib, to which is fixed the End of the internal intercoſtal Muſcle, being farther from the ſupported Points, muſt move; thus an inferior Rib will not mount by the Contraction of the internal Plan, but the ſuperior Rib will deſcend; we have nothing to examine in the laſt falſe Ribs, and we ſhall ſee that this is exceedingly well founded. 2*dly*, In Inſpiration, ſays Mr. *Bayle*, the external Muſcles are contracted, and the internal relaxed, ſince they are longer; the internal Muſcles therefore act not in Inſpiration, *vice verſa*, the internal Muſcles are ſhorter in Inſpiration, by which they are contracted, and conſequently they pull down the Ribs and ſerve in Expiration. We don't doubt, as Mr. *Bayle* ſays, but that the internal Muſcles are not longer in Inſpiration; to be convinced of this, let us but conſider their oblique Poſition, it is impoſſible then that an oblique Cord, which is fixed to two parallel Plans, as the internal Muſcles, ſhould not be elongated, when theſe Plans will be rendered horizontal.

REMARK XLI. *Of the Mediaſtinum.*

THE Mediaſtinum is nothing but the Aſſemblage of the two Laminæ which are fixed under the Sternum and go to the Spine; they are a Continuation of the Pleura. After having taken off the Mediaſtinum from the Sternum, we remove the two Membranes; we ſee in this Space the Thymus, which, by the removal of the Membranes, has two Membranes, which appear diſtant enough the one from the other, but are faſtened together when the Membranes are drawn near again; the Membranes of the Mediaſtinum, after having given room to the Pericardium, unite; they are ſeparated at laſt to incloſe the Œſophagus and the Veſſels that paſs through the Duplicature. *Rudbeck* obſerved lymphatic Veſſels in the Mediaſtinum; he repreſented them in the Tables which he publiſhed: according to him they run into the Reſervoir; but he is miſtaken, theſe Veſſels belong to other Parts. As the Mediaſtinum is but a Continuation of the Pleura, the ſame Diſtempers which infect the one can, in the ſame manner, infect the other; Inflammations, Tumours, Abſceſſes, may there happen; the Lymph may be ſpilt in the middle cellular Subſtance, and conſequently cauſe there a Dropſy, as in the other Parts. As for the uſe of the Mediaſtinum, it ſhews the Induſtry of Nature, who knows to prevent all Inconveniencies, and cauſes the Means which ſhe makes uſe of to be of Service for many things at the ſame time. The Lobes of the Lungs are very large; if they were not ſeparated they would fall the one on the other, when in a reclined Poſture; Reſpiration and Circulation would ſuffer by this Compreſſion. It was *a propos* that the Œſophagus was not looſe, and that it could not be compreſſed by the Weight of the Lungs; Nature provided it with a Situation between theſe Membranes, the Veſſels of the Blood; the thoracic Duct could not but have been incommoded by the Motion or Tranſpoſition of the Lungs. It is to prevent this Inconvenience that they are ſhut up by a kind of Covering which the Duplicature of the Mediaſtinum gives them: But had not the Heart above all need of a Place which could have encloſed it in its Situation, and which could, if we may ſo ſay, form a Caſe which ſomewhat ſuſtains the Effort of the Lungs? It is this which appears in the widening of the Mediaſtinum that receives the Pericardium.

REMARK XLII. *Of the Pleura.*

THE Pleura is compoſed of two thin Laminæ, not eaſily to be ſeparated in new born Infants, as *Ruyſch* obſerves; the Surface of the internal Lamina towards the Lungs is ſmooth and poliſhed; the Surface of the Lamina towards the Ribs is rough: there are Fibres that are fixed to the Trunk of the Thorax. If we compreſs theſe two Laminæ between the Fingers there iſſues out a Fluid; according to *Malpighi*, this was neceſſary to moiſten the Parts and to keep them flexible. When we find double Membranes we may always conclude that there iſſues out a Humour by Compreſſion; it proceeds from the cellular Texture which is between them both, and which receives Veſſels. There is no need of Glands for the Expreſſion of that Fluid, Tranſudation only through the Orifices, which are for that Purpoſe in the Arteries, is ſufficient. Glandular Grains that we ſometimes find in the Pleura, after certain Diſtempers, are not a Proof that there are Glands; they are nothing but Concretions formed by the Diſorders found in the Veſſels. To have a true Conception of the Form of the Pleura in the Thorax, we have nothing to do but to conceive of a Membrane that is extended on both ſides of the Thorax, and towards the Sternum; there it continues with the Mediaſtinum, and with the Coverings that embrace the Viſcera of the Breaſt; they are all of one Production. The Veſſels that are in the Pleura are very conſiderable; hence it happens that it is ſubject to Inflammations, and that the Blood when ſtop'd there may become very thick; as we obſerve in thoſe who have died of a Pleuriſy.

REMARK XLIII. *Of the Thymus.*

THE Thymus is one of the Parts of the Fœtus whoſe uſe is not as yet diſcovered. *Verheyen* believes that it filtrates the Humour which is found in the Pericardium, but I know not on what Foundation; there is no Reaſon that can ſupport this Opinion. *Vercelloni*'s Sentiments are theſe: The Blood of the Fœtus, ſays he, which is very ſerous, cannot eaſily paſs into the Extremities of the bronchial Arteries, which are very ſmall; hence it ariſes that the Thymus propels the Seroſity into the Fœtus, and ſends it into the tracheal Artery and Lungs; but the ſame happens not to young and old People, their Blood has Force enough to penetrate the bronchial Arteries; and thus the Thymus propels the Seroſity no more. The bronchial Arteries, which, if we may ſo ſay, we ſee nothing of but Lineaments in the Fœtus, is a Proof of what I advance: thus thinks *Vercelloni*; nevertheleſs this is nothing but an Idea ſupported by Chimeras.

Bellinger has more Reaſon to believe that the Thymus ſerves for the Nouriſhment of the Fœtus. 1*ſt*, There has been a Chyle found in theſe Veſſels. 2*dly*, There has been a Duct found out in the Veſſels that communicates with the ſalivary Glands; it is poſſible that the Chyle is filtrated within, and flows towards the Places neceſſary for Nouriſhment. Laſtly, as the Lungs begin to act, the Fluids enter no more ſo eaſily into the Thymus; hence it is obliged to diminiſh gradually.

REMARK XLIV. *Of the Diaphragm.*

THE Diaphragm has received many Names, which will be needleſs to mention here; it was looked upon as a Muſcle only, before *Jaſpard Bartholin*; and the Figures of it are no leſs defective than the Deſcriptions; the Muſcle is double, the ſuperior Muſcle is fixed to the Ribs circularly, and its Centre, which is the middle of the Diaphragm, is aponeurotick: This Aponeuroſis is fixed to the interior Muſcle; according to *Steno* we may by that look upon the Diaphragm as a digaſtric Muſcle. The inferior Muſcle comes from the Vertebræ of the Loins, it is held above by nothing but the Aponeuroſis; it ſeems that the Fibres are mixed at the inferior Part, but this is not done but by means of the Tendons. The Appendices are not of the ſame length, as we commonly ſaid; in Men the right Pillar ſurpaſſes the left, both by its Length and Number of its Fibres: It is the ſame in the Ox, but the contrary is ſeen in Dogs. When we are ſpeaking of the Tendons of that Muſcle, we muſt not ſay, that there are two, ſince every Appendix has ſeveral.

We commonly ſay that the Diaphragm has two Holes, one on the right ſide in the nervous Part, for the Paſſage of the Vena Cava; another at the left, which is larger and more behind, to let paſs the Œſophagus, with two Nerves that go to the Stomach: There is no Hole for the Œſophagus in the nervous or tendinous Part; the Hole which gives it Paſſage is in the ſuperior fleſhy Part: It is the Fibres of that Muſcle that ſeparate to receive the Œſophagus: after having been ſeparated they unite and are divided anew, to form a Paſſage for the Veſſels.

Gaſpard Bartholin obſerved in Oxen, that from the lateral part of the ſuperior Muſcle of the Diaphragm there is a tendinous Expanſion, which is continued with the ſuperior part of the tranſverſal Muſcle; this made the Anatomiſt ſuſpect, that the Motions of the Muſcles were very ſympathetic. As the Diaphragm, adds he, is ever veſted with the Peritonæum, ſo is the tranſverſe Muſcle likewiſe; upon this he explains the Action of the trigaſtric Muſcle.

Birds have no Diaphragm, but they have Muſcles that produce the ſame Effect; there go from their Ribs muſcular Fibres that are inſerted into the Membrane of the Lungs; theſe Muſcles ſerve, according to *Gaſpard Bartholin*, to expreſs the Air from the Veſſels of the Lungs.

The Action of the Diaphragm is difficult enough to be explained; we may judge of it by the Number of different Opinions that have divided the Anatomiſts. Here is an Example which will ſhew of what uſe this Partition is in Reſpiration: Take a Veſſel of Glaſs which has no Bottom, and whoſe Opening is very ſmall; put a Tube to the Orifice of a Bladder which you will ſtraitly fix there; place that Bladder in the Veſſel of Glaſs, in ſuch a manner, that the Tube paſſes through the Orifice; ſhut the Space which will be found between the Tube and Partitions of the Orifice of the Bladder exactly; then take a Membrane, with which you will ſhut the Bottom of the Veſſel in ſuch a manner that it be lax and ſunk within; when you have fixed it to the Sides, draw the Bottom with a String without, and you will ſee the Bladder ſwell. This is the true Action of the Diaphragm, which, while it is drawn towards the Abdomen, gives the Air room to ſwell the pulmonary Veſſels.

I know not what *Wolfred Senguerd* pretended, when he advanced, that the Diaphragm was not neceſſary in Reſpiration; which, according to him, may be performed by the Expanſion and Depreſſion of the Abdomen. 1*ſt*, It is certain that a ſudden Compreſſure of the abdominal Muſcles may propel the Diaphragm towards the Lungs, and expreſs the Air. 2*dly*, If it could happen that theſe ſame Muſcles ſhould be raiſed all at once, in ſuch a manner that there ſhould remain a Vacuum in the Abdomen, it is certain that the Lungs might be inflated; but by what Mechaniſm can theſe Muſcles be raiſed ſo? 3*dly*, The Machine he made to prove his Opinion, has no likeneſs with that which he pretended to expreſs: He takes a ſecond cylindric Veſſel, which he joins to that we have been ſpeaking of, and by the different Swellings he cauſes in the Bladder which repreſents the Lungs, by means of the Bladder which he placed in the ſecond Veſſel, he imagines to demonſtrate what he advances. It is neceſſary that two Machines ſhould be like one another, for by the one we may conclude for the other: I ſhall not ſtand to ſhew the Difference, we are preſently ſenſible of it. 4*thly*, What may happen by the Action of the Muſcles of the Abdomen, may be reduced to what I am going to ſay: When there happens a ſudden Contraction in the Muſcles of the Abdomen, the Diaphragm may be puſhed upwards, in ſuch a manner, that the Air is expreſſed by that Means through the Veſſels of the Lungs; when the contracted Muſcles relax, then the Diaphragm will follow them in their Relaxation, for otherwiſe there would be a Vacuum left in the Abdomen: But that Effect is not very conſiderable, becauſe the external Air which compreſſes the Abdomen permits not a Vacuum; beſides, the Muſcles in relaxing are filled with Blood, and thus they will not leave the Air which comes into the Lungs much room to play in. *5thly*, Reſpiration, or the Motion of the Diaphragm, which may be thus performed, is not common; ſuch an Action of the Diaphragm cannot happen but when the common Organs of Reſpiration are found raiſed; then by a violent Action of the Muſcles of the Abdomen we puſh the Diaphragm. As theſe Muſcles are in a violent State during this Contraction, the Relaxation which happens will put the Abdomen more at large, and permit ſome Air to enter the Lungs. *6thly*, Entirely to deſtroy *Wolfred Senguerd*'s Opinion, we have nothing to do but to recount the Experiment, which ſhews, if we raiſe the Abdomen of a Dog, and leave him but the intercoſtal Muſcles and the Diaphragm, Reſpiration will be perfectly performed; but when we cut the diaphragmatic Nerves, the Animal appears immediately out of Breath; beſides, Wounds of the nervous or fleſhy parts of the Diaphragm are all mortal.

Ortolobius pretends, that the Motions of the Diaphragm depend on the Heart; he ſays, that the Ventricles being inflated, draw the Pericardium upwards, and conſequently the Diaphragm. But certain it is, that the Motions of the Heart and Diaphragm are not performed at one time. *Velthuſius* judiciouſly remarked, that the Intervals which were perceived between the Pulſations of the Heart, were the ſame whether Reſpiration was ſtop'd, or continued according to its natural Swiftneſs. *Lower* ſpeaks more exactly than *Ortolobius*, in ſaying, that as the Man is raiſed on his Feet, it was neceſſary there ſhould be a Connexion between the Pericardium and Diaphragm, ſo that the Liver and other Viſcera hung on the Diaphragm might not draw it away, and by that means be an hindrance to Reſpiration; therefore in four footed Beaſts, whoſe Diaphragm is puſhed in the Thorax by the only Weight of the Viſcera of the Abdomen, this had been of no Service in Inſpiration, and would have been an Hindrance in Expiration. I will not mention the Sentiments of that Author who writ Notes on the Treatiſe of *Thruſton* on the Subject of Reſpiration. I believe, ſays he, that the Diaphragm is only inſtead of a Partition, and that it ſerves to hinder the Viſcera of the Abdomen from incommoding the Lungs. The Experiment which we have been ſpeaking of ſhews the contrary; it is certain that Reſpiration ceaſes when the Diaphragm is wounded.

The Diaphragm has a Motion from above downwards, *i. e.* in Inſpiration it moves towards the Abdomen, and in Expiration towards the Lungs; from the Concave which was therefore on the ſide of the Inteſtines, it is flatten'd; Diſſections of live Animals and Wounds of the Abdomen in Men are a convincing Proof of it.

The Diaphragm performs that Motion either by the Preſſure of the Lungs, or by the proper Contraction; the Lungs are not a Cauſe of its falling, ſince this even happens when we have tied the diaphragmatic Nerves; nevertheleſs there is a great deal of Difference, as we may ſee, in trying the Experiment.

If the Action of the Diaphragm depends on it ſelf, or is performed by the muſcular Fibres which are towards the Sides, or by the inferior Muſcle, the muſcular Fibres which are towards the Sides cannot become ſhorter, unleſs the nervous Center approach the Ribs; it cannot approach if it be not drawn, and conſequently it approaches not more to the right Line; but the Action of the inferior Muſcle is the principal Inſtrument of Motion of the Diaphragm; it cannot contract as we may ſee, by only viewing the Fibres, but it muſt depreſs the nervous Center.

But what Cauſe is it that gives Motion to the Diaphragm? it is that which contributes to put the intercoſtal Muſcles into Motion. We ſhall talk of it hereafter, in giving the Mechaniſm of Reſpiration.

The Diaphragm was abſolutely neceſſary for Reſpiration. *1ſt*, As the Ribs of one ſide are diſtant from thoſe of the other, in Inſpiration there would have been a Force wanting that might have hindered the falſe Ribs from removing too much from one another; for as they have no Point of firm Support, the Muſcles that raiſe them would have carried them too much outwardly. *2dly*, It was neceſſary that the Space of the Thorax ſhould dilate, ſo that the pulmonary Veſicles might be inflated; the Diaphragm facilitates this Dilatation. *3dly*, A Muſcle would have been neceſſary to propel the Excrements downwards; Nature employed the Diaphragm, which in augmenting the Cavity of the Thorax, preſſes the Inteſtines. *4thly*, As the Diaphragm draws the Ribs on all Sides, we ſee it muſt puſh the anterior Cartilages of the falſe Ribs towards the Vertebræ. *5thly*, When the inferior Muſcle contracts, the two laſt falſe Ribs muſt be drawn downwards. We ſee by what we have already ſaid, that the Diaphragm only can augment the Cavity of the Thorax; thus it may happen that we can't reſpire but by its Fall and Elevation; and this alſo happens when ſome Diſorder hinders the Motion of the Ribs.

The Hickup is one of the Phænomena which depend on the Diaphragm; for it is nothing but a ſudden Inſpiration which is occaſioned by ſome Irritation of the ſuperior Orifice of the Stomach, when we ſwallow ſomething which cannot eaſily flow in the Stomach.

REMARK XLV. *Of Reſpiration.*

WHEN the Trachea Arteria is come to the fourth Dorſal Vertebra, it divides into two large Branches, which divide at laſt into an infinite Number of others; thus every ſmall Ramification terminates in a membranous Bag, which reſembles a Kernel of a Raiſin fixed to its Tail; the two great Lobes are compoſed but of a Heap of theſe ſmall Kernels, which, as *Ruyſch* ſays, form two Lobes in the left Side, and three in the right, but they are divided into an infinite Number of ſmall Lobes; that one little conſiderable Branch may be divided into ten or twelve. For Example, theſe ten or twelve ſmall Ramifications, which are terminated by ſo many ſmall Bags, form a Knot which makes a ſmall Lobe; they do not communicate together through Holes which are in the Veſicles, but the Air only which is there contained may aſcend through the Ends of theſe Veſicles, and enter into the others through the Ramifications of the Trachea Arteria to which the ſmall Bags are fixed; theſe Interſtices of the Lobes receive the largeſt Ramifications which run into the Lungs. Let us obſerve how the ſmall Veſſels are introduced between the Veſicles. The celebrated M. *Malpighi*, from whom I have taken that which I have been ſpeaking of, has made ſeveral Remarks thereon; Spaces are found between the Veſicles, but theſe Spaces are not Interſtices which contain nothing, this is what is obſerved thereon: In the Partitions of theſe ſmall Interſtices are the ſanguinary Veſſels, whoſe Ramifications cover the Partitions of the Veſicles. *Malpighi* doubted a long while, whether there were true Inoſculations between the Arteries and pulmonary Veins, but in the ſecond Letter he ſent *Borelli* he is for Inoſculations. It is true, ſays he, that in perfect Animals it ſeems that the Veſſels end and are open, nevertheleſs it appears that theſe Veſſels, the ſame as in Frogs, extend farther in the Shape of a ſmall Net. As the arterial Veſſels are continued, ſince they come from the ſame Trunk, and that the Veſicles which contain them are formed of the ſame Membrane, we ſee that theſe Veſicles have a Communication the one with the other; this alſo is confirmed by Experience. But the Veſicles of the Trachea Arteria which are an Expanſion of the Subſtance of the Bronchia communicate not with the veſicular Interſtices which they leave between them: This is the general Idea of the Lungs, let us take notice of their Action; the Principal is Reſpiration, we muſt examine how it is performed. Before we enter into a Detail I will give an Example, which will demonſtrate the Mechaniſm, according to which Nature produced this alternative Motion.

Take a Bellows, place in its Cavity a Bladder whoſe Neck muſt be fixed to the Partitions of the Bellows, in ſuch a manner that the Air may enter the Bladder, and not the Cavity which ſurrounds it; this done, raiſe but the Partitions of the Bellows, the Air will enter into the Bladder and will inflate it, and this is Inſpiration: Let theſe Partitions fall by their Weight, the Air which was in the Bladder will be expreſs'd, and this is Expiration; the Idea would be perfect, if we had drawn the Partitions of the Bellows with Strings fixed at length.

By what I have ſaid we ſee in order that the Air be thrown into the Lungs it is neceſſary that the Thorax ſhould be widened; as there would then be a Space between the Sides of the

Thorax and Lungs, it is neceſſary that the Air by its Weight be thrown into the Veſicles of the Trachea Arteria, and inflate them juſt as it dilates the Bladder put into the Bellows; we may hence decide all theſe Queſtions aſked by Phyſicians not much vers'd in Philoſophy, *viz.* 1*ſt*, Whether the Lungs draw or ſuck in (if we may ſo ſay) the Air? 2*dly*, Whether the Air enters not the Lungs but by the Impulſe it receives from the Thorax? We can't ſay that the Air is drawn by the Lungs, for it would be as impertinent as if we were to ſay that the Water which aſcends through the Pumps is drawn by the Partitions of the Ducts. A Man muſt be ignorant of the firſt Principles of the Weight of Fluids, to ſtop at the ſecond Queſtion as at a great Difficulty; it is true that the Thorax propels the Air which environs it, but that Air by its Weight only enters with Force into the Lungs. There was an Author, who, to prove that the Air entered not into the Lungs becauſe it is propel'd, ſays, we may reſpire if we take a very long Tube which is ſhut at the Bottom in ſuch a manner that the Air could not enter there, if the other End was in the Mouth; hence, ſays he, it is evident that the Air enters not the Lungs, becauſe it is propel'd by the Thorax: This is without doubt a Proof; but we muſt obſerve, that when the Air enters from this Tube into the Lungs, it is but by its Spring, the Thorax beginning to widen, the Spring of the Air of the Tube which is equal to the Weight of the external Air, puſhes the Lungs againſt the Sides of the Breaſts and dilates them; but this Dilatation is not ſo ſtrong as that which is occaſioned by the Weight, for the Weight of the Air diminiſhes not in the Lungs; on the contrary, the Air being more ſubtile when it has left the Tube, at leaſt in its

Force, than when it is heaped together, the ſame as a Stick ſomewhat crooked, has leſs Force than when it is ſtraitened.

After having ſeen the Mechaniſm by which Reſpiration is performed, we make uſe of Inſtruments which Nature has employed for that Purpoſe; we have already mentioned the Diaphragm, we muſt ſpeak of the other Muſcles; ſome ſerve for Inſpiration, others for Expiration. The firſt we attribute the Dilatation of the Thorax to are the Muſcles called Scaleni; the firſt takes its riſe by a fleſhy beginning of the anterior part of the tranſverſe Apophyſes of the ſecond, third and fourth Vertebra of the Neck; it deſcends obliquely before, and is inſerted by a Tendon in the firſt Rib; the ſecond begins by a fleſhy Original at the lateral part of the tranſverſe Apophyſes of the ſame Vertebra, it paſſes above the firſt Rib, and is inſerted in the ſecond, and alſo in the third; it is tendinous at its Inſertion; the third ariſes by a fleſhy beginning of the lateral anterior Part of the tranſverſe Apophyſes from the ſame Vertebræ, and beſides that of the fifth and ſixth it is inſerted generally into the firſt Rib. Theſe Muſcles ſerve not for Inſpiration, altho' we ſay, 1*ſt*, The Neck is not a fixed Point in regard of all theſe Muſcles, which conſequently cannot have all the ſame Uſe. 2*dly*, The Neck being crooked, Inſpiration is performed equally. 3*dly*, We perceive no Tenſion in theſe Muſcles during Inſpiration. 4*thly*, The firſt Rib has ſcarce any Motion. 5*thly*, Theſe Muſcles, although they be in a Direction proper to raiſe the Ribs, have nevertheleſs an Action different enough from that of the external intercoſtal Muſcles; notwithſtanding this, an Author believed, that when the Muſcles which are ſubſervient to the Motions of the Neck begun to ſtrengthen it, and by that to form a fixed Point, it was neceſſary that the Action of the Scaleni ſhould raiſe the Coſtæ, but we ſay that then they alſo ſtrengthen the Neck more in agitating.

The ſecond Muſcle proper for Inſpiration is the Serratus Minor Anterior one, which takes its Origin by a fleſhy beginning from the caracoide Apophyſis; it deſcends oblique before, and is fixed to the oſſeous anterior Part of the ſecond, third, fourth and fifth Rib; this ſerves as the reſt for Inſpiration, the Omoplate for that Purpoſe ſhould have been a fixed Point, which it is not.

The third Muſcle thought to ſerve in Inſpiration is the Serratus Major Anterior, which comes by a fleſhy Rib from the bottom of the Shoulder-blade; it deſcends obliquely, and is fixed to the eight ſuperior Ribs by Digitations; this Muſcle ſerves not for Inſpiration. 1*ſt*, We can't deny that the two ſuperior Portions of that Muſcle draw the Ribs down, the inferior Portion only remains therefore. 2*dly*, This inferior Portion has no fixed Point. 3*dly*, We muſt look on the inferior Portion of the two Muſcles as a Band which environs the Thorax anteriourly, and which would be drawn poſteriourly by ſome Force, ſuch a Band would only compreſs the Thorax. 4*thly*, The Direction of the Fibres of that part of the Serratus Major is not the ſame as the Direction, according to which the Ribs ſhould be raiſed. 5*thly*, When we reſpire, we perceive no Action on that Muſcle. 6*thly*, When the rhomboide Muſcles, the *Relevator*, and the *Trapezius* contract, the Serratus Major is drawn alſo; but this raiſes not the Difficulties of which we have been ſpeaking, conſequently

quently the drawing of that Muſcle contributes not to raiſe the Ribs. *7thly*, When theſe Muſcles of which I have been ſpeaking are relaxed, Inſpiration is performed very freely; we muſt therefore ſay that the Serratus Major acts not, for then it has no Point of Support.

The fourth Muſcle is the Serratus Poſterior, it takes its Source by a Tendon from the Spiny Apophyſes, two inferior Vertebræ of the Neck, and alſo from the three Superior of the Thorax, it is inſerted obliquely to the ſecond, third and fourth Rib; we have nothing to do but to look on the Direction of the Fibres, we ſhall ſee that their Action cannot raiſe the Ribs; this Muſcle is rather one of thoſe which act upon the Neck.

The fifth Muſcle which we would attribute Inſpiration to, is the Serratus Inferior Poſterior, which comes by a large Tendon from three inferior Vertebræ of the Back, and the two ſuperior of the Loins; it terminates at the four falſe inferior Ribs. We ſaid, that by the Direction of theſe Fibres, which from an horizontal Plane ſend off ſome upwards, it was neceſſary that the Ribs ſhould be drawn downwards and outwards, ſo that the Diaphragm in Inſpiration draws not theſe ſame Ribs internally; hence it was ſaid, that the Cavity of the Thorax augmented, but firſt if it ſerved for any thing in Reſpiration, it would lower the Ribs, thus it would contribute more to Expiration than Inſpiration; there is an Appearance of its ſerving as an Antagoniſt to the Muſcles of the Abdomen, to ſtrengthen the Thorax, and above all the falſe Ribs, I ſhall not mention the Subclavian, ſince having no fixed Point it cannot draw the Ribs upwards.

Theſe are the Muſcles of Inſpiration; as for what regards Expiration, the Muſcles of the Abdomen perform that; it is certain it cannot contract, that they ſtraiten not the Breaſt in drawing the Ribs downwards: I do not believe nevertheleſs, that they have a great Share in Expiration; as they are pulled in Inſpiration they put themſelves in their former State, when the Contraction of the Muſculi Inſpiratores ceaſe; but neither do theſe Muſcles nor others, of which we have been ſpeaking, ſerve much to lower the Ribs in Expiration, as I ſhall demonſtrate hereafter. I will give nothing here but a Reaſon which oppoſes all the Uſes that have been given in Inſpiration to the Muſcles we have juſt been making mention of; it is, if we raiſe the Muſcles of the Abdomen in a Dog, with thoſe which we have juſt examined, Inſpiration and Expiration are performed as before.

After having examined the Muſcles which act not in Inſpiration, we muſt obſerve thoſe which do; there are almoſt no others but the intercoſtal Muſcles and the Diaphragm. As we have already explained their Action, it is not neceſſary that we ſhould make any Delay: Theſe Muſcles contribute but to the Elevation of the Thorax, we muſt look why it is ſtraitened in lowering the Ribs. 1*ſt*, The Ribs can't be raiſed, unleſs the Cartilages which fix them to the Sternum are bent. 2*dly*, Theſe bended Cartilages, being elaſtic, muſt endeavour to be re-eſtabliſhed. 3*dly*, The Ribs being raiſed puſh the Sternum by its inferior Part; the Sternum being puſhed more outwardly towards the inferior Part muſt firſt bend a little; ſecondly, the Ligaments that fix it to the Ribs muſt be pulled; theſe two Things ceaſing they are lowered, and the Ribs with them. Thirdly, We have ſaid, that the ſacrolumbal Muſcle could ſtraiten the Thorax in lowering the Ribs; but as the Ribs roll from Top to Bottom upon their Articulation which is double, and that the great Action of the Ribs is at the lateral anterior Part, I cannot ſee how that Muſcle can be of great Service in Expiration. Let us examine now the Cauſe which reciprocally produces Relaxation and Contraction in the intercoſtal Muſcles.

There is nothing more difficult than the Cauſe which obliges the intercoſtal Muſcles to dilate and leave the Thorax compreſs'd. *M. Pitcairn*, after *Bellini*, looked on the Muſculi Inſpiratores as having no Antagoniſt. Hence theſe great Philoſophers concluded, that the Muſculi Inſpiratores ought to contract and raiſe the Ribs, ſince they have no Antagoniſt to be an Hindrance to them; the Thorax then dilates, but in this Dilatation there happens, according to them or their Followers, two Things, which are at laſt Cauſes of Expiration. 1*ſt*, The muſcular Fibres by their reiterated pulling by many Impulſions, raiſe the Ribs above the Point where they would be in Equilibrium by their Reſiſtance with the Action of the Muſcles. 2*dly*, The Air which enters with Rapidity acquires more Force in deſcending, and by its diverſe Impulſions puſhes the Ribs above the Point where the Equilibrium we have juſt been ſpeaking of would be. 3*dly*, After the Ribs are puſhed above their Point of Equilibrium, the Motions of the Cauſes which puſh them diminiſh, they are found ſtronger, then they relapſe and ſtraiten the Thorax; but juſt as they were mounted above the Point where they ſhould remain to be in Equilibrium, ſo they alſo go farther than they ſhould in deſcending, the intercoſtal Muſcles therefore act anew as before; thus Reſpiration having once begun, muſt never ceaſe. To confute this Opinion,

nion, we have nothing to do but to aſk why the Coſtæ and intercoſtal Muſcles are not in Equilibrium. If we fix very fine elaſtic Cords to the Bellows which we have made mention of in ſuch a manner, that they may raiſe the Sides, ſo that the Bladder may be inflated, and join the two Sides of the Bellows in ſuch a manner that there may be ſome Machine or Spring ſomewhat to oppoſe their Separation, we ſhall ſee whether the alternative Motions of theſe Bodies will continue long. If we propoſed this Queſtion to the meaneſt Mechanick, he would ſay immediately that theſe Motions could not continue; is it not ſurpriſing that able Men ſhould maintain that this is ſufficient to explain the Motions of Reſpiration? I will not ſpeak of freſh Subjects where the Muſcles may ſtill have ſome Contraction, as we ſee in Diſſection; according to *Pitcairn* and *Bellini*, Reſpiration ſhould continue ſome time after Death.

Baglivi little ſatisfied with what has been writ before him, gave us another Cauſe for Reſpiration; he tells us, thoſe were miſtaken, becauſe they always took the Cauſe for the Effect. They believed, ſays he, that the Air entered, becauſe the Thorax dilates, when on the contrary the Thorax dilates not, but by the Action of the Air. It is the ſame, according to him, as a perpetual Bellows, when we place a Tube in ſuch a manner that one Extremity anſwers to the Chimney Hearth, and the other is out of the Houſe, the Air which is out is more condens'd, and conſequently heavier than the Air which is round the Fire of the Hearth, it muſt therefore enter and expel the other; but as it rarefies in its turn, it is forced to give place to that which follows it; in this manner it is that *Baglivi* would have Reſpiration

tion be performed: The external Air enters into the Cavity of the Lungs by its Weight; then the Heat rarefies it, and this Rarefaction raiſes the Ribs in magnifying the Capacity of the Thorax; then the external Air, which is heavier than the internal Air which is rarefied, makes the Ribs fall down again; theſe Motions, according to that Author, continue in the ſame manner till the Deſtruction of the Machine. We might confute this Opinion, and aſk only, whence comes it that in thoſe who are juſt dead Reſpiration is not continued longer, ſince the Heat is ſtill very conſiderable. But there is another Reaſon to overthrow it entirely, for if Reſpiration is performed in that manner, whence comes it that when we open the Thorax the Lungs ſink down, and Reſpiration ceaſes; the internal Heat is nevertheleſs conſiderable enough, ſince the Animal lives ſtill. To demonſtrate the Miſtakes and ridiculous Opinions of Authors of vaſt Reputation, let us examine what happens by the Rarefaction of the Air. 1*ſt*, How will the external Air enter into the Lungs of an Infant newly born? It cannot do it by its Weight, all the Weight of the Atmoſphere preſſes the Breaſt, conſequently this ſame Weight will not dilate the Lungs. *Baglivi* reaſoned thereon, as he had ſaid that the Air by its Weight can remove the two Sides of a Bellows which would be exactly tied one to the other, which is ridiculous. 2*dly*, Whenever the Air ſhould enter into the Lungs, what would be the Conſequence? If it rarefied all at once, it would extend in Places where it would find leſs Reſiſtance, for the Air which is at the Entrance of the Mouth would reſiſt it leſs; for if it raiſes the Ribs, it is neceſſary to conquer their Reſiſtance, and that of the Air which preſſes them; it is therefore evident that it will extend through the Trachea Arteria, ſo much the more as the external Air will aſſiſt it by its Preſſure on all the Body; how by that will be performed the Elevation of the Ribs? and moreover, how could this Air which will be gone out enter again? The Difficulties that I have demonſtrated in the firſt Article, prove the contrary. 3*dly*, *Baglivi* ſays, that the Preſſure of the external Air cauſes the Air which has inflated the Breaſt to ruſh out, but muſt not this happen as ſoon as this Air begins to rarefy? I don't ſee why the external Air ſhall wait till this which is within ſhall raiſe the Thorax; it muſt act from the firſt Effort, which this internal Air is the occaſion of dilating. 4*thly*, We have nothing to do but to make a Machine in which the Air heatens extraordinarily, and we ſhall ſee if the alternative Motions will begin and continue we ſhould be laugh'd at, if we were to maintain this.

Bergerus is believed to have found the Cauſe of the alternative Motions of Reſpiration in the Air which remains always in the Lungs after the firſt Expiration; this Air rarefied by Degrees dilates the Lungs; it is true there always remains ſome Air which is continually heated by the Warmth; but 1*ſt*, this Air can't cauſe the firſt Inſpiration, ſince there is no Air in the Lungs of thoſe that are newly born. 2*dly*, This Air, if it were capable to inflate the Lungs, might hinder the external Air from entering, for it would have more Force. 3*dly*, The Animal reſpires no more, as ſoon as we have raiſed the Sternum; nevertheleſs the cloſed up Air might produce the ſame Effect as before. 4*thly*, The Air can't ſerve for a *Stimulus*; it would follow hence, that Inſpiration would be performed always by the Command of the Will, which is falſe.

There have been Philoſophers who explained Reſpiration in the following manner. As ſoon as in a human Body there is ſome Part wounded, immediately the Power which moves our Machine is tranſported there, if we may ſo ſay; or to ſpeak more exactly, it acts in that Part with greater Force. For Example, when we perceive our Hand a burning we take it back immediately; when we even ſleep, if we paſs ſomewhat that tickles the nervous Papillæ of the Lips, the orbicular Muſcle immediately is put into Action. Again, we ſee that thoſe who ſleep put their Hands on Places where they feel an itching, ſo that the Muſcles which are wounded enter into Contraction. 2*dly*, This Principle being laid down, what will be the Conſequence, when the Blood, unable to circulate more freely, will dilate the pulmonary Artery? Then the feeling of ſome Trouble which ſucceeds this Stoppage of the Blood, gives Intelligence, if we may ſo term it, to the moving Power to draw the Reins, and to act on the intercoſtal Muſcles, which being about to contract, dilate the Thorax; after the Cavity of the Breaſt is become larger, the pulmonary Veſicles will inflate; the Veſſels will be diſplayed, the Interſtices which are between the tracheal Veſicles will become more ſpacious, the Blood, without Difficulty, will flow into the Arteries; but as the Blood will inflate the Veſſels very much, while the Lungs will be filled with Air, we ſhall perceive a new Uneaſineſs; this Uneaſineſs gives the moving Power Intelligence to relax the Reins, ſo that the Ribs may be pulled down by their Weight, and put the Muſcles which can ſtraiten the Breaſt into Action. This Opinion can't be ſuſtain'd; it would be impoſſible that the Hand, for Example, ſhould always remove alternatively to deliver us from ſome Uneaſineſs, without obſerving that this proceeds from our Will, and that it is but a diſagreeable feeling which bears us to this Motion; we ſhall perfectly perceive this in waking, but we never feel any Uneaſineſs or *Stimulus*, a Term thoſe who maintain this Opinion make uſe of, Reſpiration is performed without our thinking of it. In an Apoplexy, where the Senſes are entirely extinguiſhed, Reſpiration is not interrupted; nevertheleſs we then are ſenſible of that *Stimulus*, during Sleep, where a Part of feeling is dull, Reſpiration is ſtronger than when awake; nevertheleſs, the contrary ſhould happen.

There were ſeveral other Opinions which I ſhall not here recite. *Ariſtotle*, and after him *Cæſalpinus*, and *Hofman* believed, that the Heart occaſioned the Dilatation of the Lungs, but for that it would have been neceſſary that Inſpiration and Expiration anſwered to the beating of the Heart.

Averroes believed, that the Lungs owed not their Motions but to a Force which was particular to them. *Platerus* and *Sennert* followed the ſame thought, and ſaid, without that there would ever be a violent Motion; as theſe Authors give no Reaſon to ſupport their Opinions, we ſhall give none to confute them. *Thomas Bartholin* who anſwered them, ſaid only, that the Lungs were diſpoſed to move, but that they contained not the Cauſe of their Motion; he advances no more than they, ſince he gives no Reaſons; he might have ſaid, that the Thorax being open, we ſee no more Motion in the Lungs; as for *Willis*, I know not what he pretended, when he affirmed, that in all the Fibres there was a natural Motion of the *Syſtole* and *Diaſtole*; this is ſaying nothing. After having confuted all theſe Opinions, we muſt give that which to us appears the moſt likely.

As ſoon as a Child is born, 1*ſt*, The Air which enters the Mouth and Noſe makes it ſneeze immediately, and puts the Diaphragm and intercoſtal Nerves into Action by that Sneezing. 2*dly*, The Blood which paſſes in great Quantity to the Aorta, acts with Force on the intercoſtal Muſcles, which being deſtitute of an Antagoniſt, are contracted more. Theſe two Cauſes contribute to dilate the Capacity of the Thorax, and conſequently to make the Air enter which then inflates the Lungs; but when the Air is entered, the Blood which diſtends the Veſſels flows not eaſily into the Veins, becauſe it is not preſs'd into the Lungs. It happens then 1*ſt*, That the intercoſtal Muſcles do no more receive ſo much Blood, for there paſſes leſs in the left Ventricle, when the Lungs are inflated. 2*dly*, There flows not then ſo much Blood in the Brain, conſequently the Nerves are no more ſo much extended; the Cauſes therefore that contract the intercoſtal Muſcles beginning to diminiſh, theſe Muſcles relax; by their Relaxation the Ribs fall, according to the Mechaniſm we have heretofore explained; the Ribs being pulled down, the Blood is expreſſed from the Lungs into the left Ventricle; then the Cauſes which gave the intercoſtal Muſcles Contraction, begin again, for the Blood is thrown in great Quantity into the Brain and intercoſtal Muſcles. This Explication ſeems to me preferable to others, becauſe it is more mechanic and more natural; the Difficulties which attend it are explained more eaſily than thoſe which oppoſe the other Hypotheſes.

We may object 1*ſt*, That this alternative Contraction will happen every where, where there are

Muſcles; but this Objection will diſappear, as ſoon as we conſider that all the Muſcles, except the Intercoſtals, have Antagoniſts; in thoſe there will not be any Change that may cauſe the Motion of the Parts which they are fixed to, ſince the Force will diminiſh or augment equally in the two Antagoniſts: as for the Inteſtines which are a hollow Muſcle as the Stomach, the alternate Motions can be there perceiv'd, and this Motion in the inteſtinal Tube will produce a ſort of *periſtaltic Motion*; but this Motion will be very different from that we have been ſpeaking of elſewhere, ſince it will happen equally and in the ſame time to all the inteſtinal Canal, there will be but an inſenſible Relaxation, becauſe there is no Force which acts againſt the Inteſtines, as the Ribs act againſt the intercoſtal Muſcles.

They object 2*dly*, That if this Relaxation was true, we ſhould perceive ſome Difference in the Pulſe, for the Blood not circulating in ſo great a Quantity, ſhould cauſe weaker Pulſations in the Arteries. To this we may anſwer, that we can't doubt but when we are ſleepy, the Parts of the Body are no more relaxed than before; neverthele[ſ]s, when we ſleep, the Pulſe is ſtronger; thus we can't conclude that the Pulſe ought to weaken in the Caſe we're talking of. Let us come to ſome Phænomena which we meet with in Reſpiration.

The Lungs tend always to ſtraiten. 1*ſt*, In Animals that die in the Air Pump we ſee the Lungs entirely collapſed. 2*dly*, It is the ſame in thoſe who die ſuddenly by Lightning. 3*dly*, If we fill the Lungs of a dead Body, the Air is propel'd by the Weight of the Lungs. All this offers no Difficulty: The Branches of the Bronchia go the one from the other at acute Angles; and as they are compoſ'd of a ſtrong Subſtance, they will reſiſt, when we remove them: We can't fill the Lungs without removing the Branches, ſince the Veſicles that are at the End will have their Centers, which anſwer to the Axis of the Branches, much more diſtant than in the Contraction. As for the Lungs of dead Bodies, we muſt obſerve, that the Interſtices that are between the tracheal Veſicles are no more filled with Blood; thus there will be Spaces formed between theſe Veſicles, and there can be no ſuch Spaces made, unleſs we find a great Reſiſtance on the ſide of the Air when we inflate the pulmonary Veſicles. We may again ſay, that the Bronchia, if the Trachea Arteria is not towards the Centre of the Earth by its Opening, weigh the one on the other, and thus they may approach each other. It follows hence, 1*ſt*, That the Air muſt have a certain Force to raiſe the Lungs. 2*dly*, That the Air becomes very light, it can't raiſe them, neither conſequently dilate them; this happens, when Animals die in the Air Pumps, and when we are ſuffocated by Lightning, for then the Air has no Force, in the firſt Caſe, becauſe it miſſes; and in the ſecond, becauſe it is extraordinarily rarefied; the Veſicles and the Bronchia muſt then fall the one on the other by their Weight. We may ſay the ſame thing of the Difficulty that we find to reſpire the Air on very high Mountains; the Air, which is there very light, cannot ſo well raiſe the Ramifications of the Bronchia: The Facility that aſthmatic People find to reſpire in the Countries bordering near *London* ſooner than in the City, proceeds from nothing but the Weight which differs by the Smoak with which this City is continually filled, and which proceeds from the Coals that they burn inſtead of Wood; we muſt not imagine that there is any Air between the Pleura and Lungs there to produce the Collapſion which we find when an Animal dies in an Air Pump. The Lungs exactly fill the Cavity of the Thorax; beſides, the Wounds of the Lungs which are accompanied by a Collapſion of the Tracheæ and Veſicles ſhew, that if there was any Air between the *Pleura* and the Lungs, Reſpiration could not be performed. I caus'd Air to enter into the Lungs and Pleura of a Dog, immediately the Animal could not reſpire; there is nevertheleſs a Difference between the Air which is encloſed in the Cavity of the Thorax, and that which enters there by Wounds which remain open. When there is Air encloſed in the Thorax, it dilates when the Cavity is enlarged; thus the external Air, which is ſtronger, becauſe it is leſs condens'd, might enter partly into the Lungs, but when the Wounds are open, the external Air can enter more into the Bronchia then in a Bladder, not inflated. *2dly*, It was aſked, whether Reſpiration was voluntary or involuntary; there is no doubt but that the Will cannot accelerate or retard it; but it is aſk'd whether common Reſpiration is not performed by an Act of the Will? It ſeems at firſt that this Queſtion is propos'd without Foundation, ſince we reſpire without thinking about it; nevertheleſs it is not without Reaſon that this is aſk'd, for when we walk, we do it without thinking on it; we are buſied with important Affairs which fix our Attention ſo much, that we make no Reflections on the Motions of our Feet; it ſeems then ſufficient that the moving Power gave the Legs a Motion, which continues without any Neceſſity of returning to a new Act of the Will; were it not poſſible that in the Occaſion we have of reſpiring, we had us'd our ſelves to raiſe or to pull down the Thorax? This Action could not continue during ſleep, in ſuch a manner, that the Power which moves our Body, might be in the Muſcles of Reſpiration by the ſame Reaſon that it makes us bear our Hand on ſome part on which we feel ſome Tittillation during ſleep: Nevertheleſs, we may ſay, that Reſpiration is not an effect of the Will, ſince it ſubſiſts in an Apoplexy where Senſe is extinguiſhed; ſome would prove that it was not voluntary, becauſe we could not ſtop it long. But 1*ſt*, *Galen* remarks, that a Slave killed himſelf by hindring Reſpiration. 2*dly*, We can't long withſtand to ſuffer extraordinary Pain, nevertheleſs it is a thing that depends on us.

3*dly*, We might perhaps believe that there is need of a reciprocal Action in Muſcles oppoſite to perform Reſpiration, and that there would be a Neceſſity, 1*ſt*, Of Muſcles which might raiſe the Thorax to make the Air enter there. 2*dly*, Of Muſcles which might contract at laſt to pull it down, and which conſequently might have an Action contrary to that of the others; but by what we have eſtabliſhed, we ſee that this is not neceſſary, for it ſuffices, that there be immediately a Cauſe which acts on the intercoſtal Muſcles, and which at laſt ceaſes to act, then the alternative Motions of Inſpiration and Expiration will be neceſſarily made. As for the Muſcles that cover the Thorax, and which ſerve to move the Arms, the Shoulder-blade, and the Neck, they may carry ſome Difference in Reſpiration; but this is rather in hindering than in aiding it, for we have nothing to do but vehemently to extend the Muſcles of the Shoulder-blade and Humerus which are fixed round the Breaſt, and we ſhall ſee that Reſpiration will be more difficult; nevertheleſs it is then only that they may be of ſome uſe, becauſe the Shoulder-blade is fix'd. We ſee by the Action of the intercoſtal

Muſcles, or of others that are in ſome manner connected to the Thorax, that it is not poſſible for the pulmonary Veſſels to have the ſame Diameter during two Moments following, for the Muſcles always dilate the Cavity of the Breaſt, or ſtraiten it, and the Blood always flows into the Lungs, or flows out of them.

4thly, The Will may, during ſome time, ſtop the Motion of Reſpiration, but it can't ſtop the Motion of the Heart; becauſe, beſide the intercoſtal Muſcles, which are deſtitute of Antagoniſts, and act with the Diaphragm by a mechanical Neceſſity, there are Muſcles that can oppoſe their Motions, when the Will makes them act; ſuch are the Muſcles of the Abdomen, and thoſe of which we have been ſpeaking; but for the Heart, there is no Muſcle that can counterbalance it, therefore the Will can't ſtop its Action: Notwithſtanding this Difference between the Action of the Heart and intercoſtal Muſcles, there is a certain Harmony between Reſpiration and the Motions of the Heart; after a certain Number of Pulſations there happens a certain Number of Inſpirations; according to the Explication which we have given, this muſt be occaſioned thus, for a certain Number of Pulſations of the Heart muſt propel a certain Quantity of Blood into the intercoſtal Muſcles and Brain; hence there muſt follow a certain Action in theſe Muſcles, and in the Nerves; but if the Lungs have need of the Heart, the Heart in its turn has need of the Lungs, for they are either full of Blood, or are empty; if they are full, it is neceſſary that they throw it into the left Ventricle, otherwiſe the Heart can't move; if they are empty, and can't receive the Blood which will circulate from all the reſt of the Body, it will be forced to ſtop at the right Auricle and right Ventricle; and thus

Circulation will be ſuppreſs'd, and Life with it; in thoſe who are ſtrangled, the Air is either ſtopt in Inſpiration, or in Expiration; if it is in Inſpiration, the Lung that is filled with Blood cannot be emptied, becauſe the Spring of its Texture is not ſtrong enough to make the Blood paſs thro' a prodigious Number of interlaced Ramifications; if it is in Expiration, the Blood can't flow between the Veſicles that are collapſed. It will perhaps ſeem, by what I have ſaid, that it would be neceſſary there be always an Expiration anſwer to every Contraction, to make the Blood circulate into the left Auricle; but an Expiration always heaps ſo large a Quantity of Blood in the great venal Veſſels of the Lungs, to fill ſeveral Times the left Ventricle; beſides, Inſpiration which inflates the Veſicles, preſſes at the ſame time the large venal Trunks, and obliges them to diſcharge into the left Ventricle. While the Fluids of the human Body are in a perfect Equilibrium, the Motions of the Heart and Thorax are very ſlow, eſpecially when the Body reſts; but as ſoon as there happens a Diſorder in theſe circulating Fluids, the Heart immediately feels it, and if it is much irritated by the Obſtacles, it propels the Blood with Force into the Inſtruments which raiſe the Thorax; all this diſorders Reſpiration; if Reſpiration is troubled by a Cough, or by ſome Diſtemper of the Lungs, the Heart in its turn muſt perceive it, and conſequently this Diſorder may extend through all the Veſſels: This Sympathy between the Motions of the Heart and Lungs, proves not that the Action of the one ought to ceaſe at the ſame time, as that in the other; in dying Bodies, for Example, the Heart and the Auricles beat a long while after Reſpiration has ceas'd; the Heart can move a long time only by the Spring of its Fibres, as we may ſee by many Experiments made on the Heart of an Eel, *&c.* Thus it is not ſurprizing that the Motion of the Heart ſurvives, if I may ſo call it, Reſpiration.

5thly, There may happen divers Diſorders in Reſpiration. *1ſt*, The Blood may be propel'd but with little Force into the Organs which raiſe the Thorax, Reſpiration then will be difficult; but if it enters there with Violence, and the Nerves are very much agitated, the Motion will extraordinarily augment, the Contractions will be ſtrong, and may become convulſive. *2dly*, If the Pleura becomes enflamed, the Ribs will not be able to move, unleſs it is diſtended, conſequently Reſpiration can't be performed but with the Diaphragm; or, if the Ribs riſe it will be but of very little Conſequence: when the intercoſtal Muſcles are wounded, we ſee that great Diſorders muſt enſue, the ſame as when the Lungs are attacked; for beſide what will happen by the Sympathy of the pulmonary Nerves with the others, the Lungs can't be preſs'd without a Perception of Pain; thus Reſpiration will be very difficult: We obſerve in the Agony of a Peripneumony, Aſthma, the Muſcles which cover the Breaſt act very much, then the Neck, Shoulder-blade, inferior Ribs, the Back, have a viſible Motion. This proceeds hence, *viz.* The ſick Perſon, to end the Pain which he feels, and facilitate Reſpiration, puts all the Muſcles which can give a different Situation to the Thorax into Motion. *3dly*, A dry and hot Air diſorders Reſpiration, becauſe it diſſipates the Humidity of the Lungs, and there leaves only a viſcous Matter, then the Heat augments with the Croud of Veſſels; thus the Motions of the Breaſt cannot be ſo eaſy, ſince the Blood is there heaped in greater Quantity, that it can't flow eaſily, and that the Parts are irritated by the Heat. *4thly*, The cold Air ſhortens the Diameter of the

Veſſels, hinders their not tranſpiring, coagulates the Blood, and thus enflames the Lungs. *5thly*, The Air which is too moiſt, relaxes the Fibres of the Lungs, permits the Veſſels to dilate, ſince their Reſiſtance diminiſhes, and the moiſt Air is lighter than the dry Air; hence it proceeds that the Blood and the Lymph are gathered in the Lungs. *6thly*, The Air which is too heavy dilates the pulmonary Veſicles too much, theſe Veſicles being too much dilated, are too much preſſed the one againſt the other, and inſtead of giving a Paſſage to the Blood, they ſhut it up; for let us take Bladders that are not ſhut, and which have a great Space to extend, they will be perfectly round when we inflate them, and will not touch but by ſome Points; but if they are ſtraitened in ſome narrow Place, then they will fill again by their irregular Figure the Space that they left empty, if they could extend freely; if there were any Canals between theſe Interſtices, they would be very much compreſs'd. *7thly*, If the Air is very light, it will not have Force enough to raiſe the Lungs, and make them obey the Dilatation of the Thorax; thus the Blood cannot enter in the Lungs. There will happen great Diſorders when the Blood can't enter into the Lungs, but when it is there in too great a Quantity, *1ſt*, It muſt preſs much of the Seroſity into the Cavity of the Bronchia. *2dly*, The Heart which receives much muſt propel a great Quantity of it into the *Muſculi Inſpiratores*. *3dly*, As the Quantity of Blood which inflates the Lungs makes us uneaſy, we reſpire the oftner to make it flow out. After having ſeen the Diſorders which may ariſe in Inſpiration, let us explain two Phenomena, of which the firſt has appeared very puzzling.

When an Animal is ſhut up in a cloſe Place which has no Commerce with the exterior Air, whence comes it that it dies ſo ſoon? 1*ſt*, In a Place where there is Air enough to fill the Lungs of the Animal, what Obſtacle can at laſt diſorder Reſpiration? 2*dly*, The Weight of that Air diminiſhes not, for we ſuppoſe the Place ſo cloſe that the Air can't iſſue out; thus there will always be found Force enough to dilate the Lungs. 3*dly*, Rarefaction can't render this Air lighter, or make it produce the Effects of a light Air, for it ſeems at firſt that there happens nothing but a Dilatation, by which the Lungs muſt be inflated with more Force, and that it is that new Force which occaſions the Veſicles, being too extended, to give no Paſſage to the Blood; it is neceſſary in this Caſe therefore that Circulation ſhould ceaſe, and conſequently that the Animal dies; but in this there is no likelihood, for by the Barometer we have found that this Air was changed little or nothing in relation to its Weight; there remains nothing to ſay, unleſs that as the Quantity of Fluids which flow from the Body by Tranſpiration is vaſtly conſiderable, the Animal, if we may ſo ſay, is ſwimming in Water; this may be an hindrance to Reſpiration; beſides the Heat which always augments in the Air, may irritate the Texture of the Lungs. There is a Philoſopher who believed, that Tranſpiration which mixed Water with Air, took from it its Elaſticity in a cloſe Place; if this were ſo, it is certain that the encloſed Air would not have Force enough to inflate the Lungs: It is true that there are Fluids which diminiſh the Spring of the Air, but I never found that it was diminiſhed by Water. When we have aſcended a high Mountain, we are quite out of Breath when we come to the Top; this proceeds from our great Inſpirations in mounting, as we may obſerve by theſe great Inſpirations which are ſudden, while Expirations are much ſlower, Blood is heaped in large Quantities into the Lungs; thus we muſt frequently expire to propel it; the Motions of the Muſcles contribute much to heap the Blood in the Lungs. Theſe are the principal Phenomena of Reſpiration, let us ſee its Uſe; for this let us examine what may happen to the Fluids that are propel'd by the Heart into the pulmonary Veſſels.

1*ſt*, If a Fluid enters from the pulmonary Artery into an infinite Number of Ramifications, whoſe Diameters become leſs and leſs, it is neceſſary it ſhould be preſs'd more in its Strainers. 2*dly*, That theſe Parts being each of them expos'd, the one after the other, to the Pulſations of the Arteries, change their Figure and cloſe. 3*dly*, That the Parts diſunite the one from the other. 4*thly*, In Inſpiration that Fluid will paſs every Moment from the Contact of the Veſicles in Places where they touch not, conſequently the Air and Heat which are found in the Lungs muſt rarefy with the Veſſels in thoſe Places; thus there will be a reciprocal continued Motion left in the Humours which are in the right Ventricle. 5*thly*, Hence it follows that the chylous Parts that enter from the right Ventricle into the Lungs, being preſſed by thoſe which follow them, and by the Veſſels in the Strainers, muſt become more ſolid; and according to the thickneſs of the capillary Extremities, three, four or five Parts will unite and take a globular Figure, then the Chyle changes into Blood. *Leewenhoeck* obſerved no other Difference between the Chyle and Blood, except that the Parts of the Blood were compoſed of more Globules; this is therefore the Union which is made. I have ſaid that there was ſtill another Separation, for theſe Globules, compoſed of many Globules ſeparate the one from the other, ſince it is neceſſary that they paſs one after the other; if the Blood is formed but in part by the firſt Circulation through the Lungs, it is formed in the following by Degrees. *6thly*, The Blood having paſs'd into the Veins, the Parts which we have been ſpeaking of mix with a great Quantity of Phlegm, and Lymph which has received great Changes, the ſame as the Blood; beſides, the Air which was compreſſed in the Strainers, diſpels the Parts of the Blood by its Spring which is freed in the Veins. *7thly*, All theſe Changes give the Chyle the neceſſary Diſpoſition which it muſt have to nouriſh the Parts. For *1ſt*, we obſerve that whilſt the Lungs are bad, the Nouriſhment of the Parts is not prepared as it ſhould be. *2dly*, When the Chyle has circulated ſome time in all the Body, it is properer to form good Milk. We may judge by this of all that we have ſaid on the aerial Nitre which was introduced into the Lungs; let us examine the Reaſons which were brought to prove that Opinion.

Authors have had different Views, when they would have proved that the Air entered into the Blood by the Lungs. *Borelli* believed, that the Air was abſolutely neceſſary to give Oſcillation to the Blood. *Sylvius* imagined, that there was need of the Air's entring into the pulmonary-Veſſels to carry there a refreſhing Nitre, in which the Blood, heated in the Heart, could not paſs. *Lower* ſaid, that this Nitre was neceſſary to give a red Colour to the Blood.

Theſe Authors, to prove that the Air entered the Lungs ſaid, *1ſt*, That the Blood is redder in circulating out of the Lungs than in entring; this may be without the Succour of freſh

Air, as we have obſerved; beſides, we cannot ſay that the Air enters into the Spleen, although the Blood circulates there more fluid and redder. *Sylvius* and *Swammerdam* ſay, that if we blow in a Trachea Arteria ſtill warm, the Air paſſes into the Heart. *Harvey*, *Highmore* and *Bohn* anſwer, that this will never happen, at leaſt if we force not the Lungs. 3*dly*, *Thurſton* having injected a black Fluid in the pulmonary Artery of a Sheep, ſays, that this Fluid run back into the Bronchia; this Experiment is confuted by the ſame Proofs as the precedent; beſides, if this were ſo, why doth not the Phlegm of the Blood in the natural State flow from the Veſſels, in the ſame manner as that Liquor, which is not more ſubtile? This Objection will appear very ſtrong, if we conſider, that when we pump the Air out of an Air Pump, the Blood ruſhes not out of the Lungs of Animals. 4*thly*, Other Authors who have conſider'd theſe Difficulties, have added others; they ſaid, that as the Air which we blow in the Jugular of a Dog kills that Animal, it might alſo produce the ſame Effect, if it entered into the Blood of the Lungs; but this Experiment did not put them to a Nonplus: The Air which we blow in the Blood by Degrees produces not this Effect; if through the Vena Cava we ſend new Air into the Blood of a ſuffocated Animal, the Heart which had no Motion is immediately awakened; but if the Air entered in too great a Quantity in the Blood, then the Veſſels would be too much extended, and could contract no more, conſequently Circulation would be ſtop'd. 5*thly*, The Air, ſay they, is abſolutely neceſſary in the Blood to counterbalance the external Air, and to divide the viſcous Matter which might too much thicken the Humours that circulate in our Body, if there were not little parts of Air which, in contracting, cauſe the Subſtances of the Blood to divide; this Diviſion is a neceſſary Conſequence of the Spring of the Air and Motion of the Heart; for the Heart can't propel the Blood, which compreſſes not the Air that is there mixed: This Air, as ſoon as the Heart ceaſes its Pulſation, will be untied by its Spring, and will diſperſe the Parts of the Blood which preſs'd it; beſides, warm'd by the Heat of the Body, it continually attempts to rarefy, which can't be, unleſs the Matter that environ it, divide. Nature who ſaw the Neceſſity of Air in the Blood, gave entrance to a large Quantity of it, as we ſee it in the Air Pump; for if we there put an Animal it ſwells immediately, and the Lungs having nothing to ſuſtain them, collapſe; as for the Blood it bubbles, and there is formed a Froth on the Surface. When the Air has been pumped out, even the ſolid Parts ſwell, and diſperſe little Globules of Air; *Boyle* and other Philoſophers made theſe Experiments. It is ſurpriſing that *Leewenhoeck* advanced, that there was no Air in the Blood or Urine, for if there was, it could be but very ſubtile and very different from that of the common Air. From all I juſt related they would conclude, that the Air ſhould enter through the Lungs into the Blood; Paſſages for that Occaſion were ſought for. *Bergerus* believes, that the Air has not need of any particular Openings to be inſinuated into the Texture of the Lungs; he imagines, that the Air may enter by the Pores of the Veſicles; he ſays, after *Borelli*, that the Parts of Air, mixed with the Lymph, concenter, and become proper to penetrate the Pores of the Veſicles: The Air, when it enters into the Fluids, diſſolves in ſome meaſure, as the Experiments of *Mariole* demonſtrate; the Particles of the Air can penetrate into the Lungs, according to *Bergerus*, as they can go out of our Bodies by Tranſpiration in the ſame manner as from Trees; to prove which, he ſays, when we blow into the Bronchia, the Air paſſes with Moiſtneſs: The ſame Thing happens, when we propel ſome coloured Fluid there, for we ſee it return with Froth through the pulmonary Vein; for this, ſays he, it is not neceſſary to force the Lungs.

The Air contained in Eggs are gathered at the Extremity acroſs their Membranes; could it not in the ſame manner penetrate our Body in coming into the Lungs? all theſe Reaſons prove not that there enters more Air through the Lungs than through the Pores of the Skin. 1*ſt*, If the Air entered into the pulmonary Veſſels, it is neceſſary that it penetrates the bronchial Veſicles. 2*dly*, It muſt be inſinuated into the Veſicles which are between the Bronchia. 3*dly*, It muſt therefore penetrate all the Membranes of the Veſſels. 4*thly*, The Air never enters into the vaſcular Veſicles, or that ſhut up the Veſſels, if it is not propel'd with Force. 5*thly*, When we blow the vaſcular Veſicles, we cannot without Force make the Air enter into the Bronchia. 6*thly*, The bronchial Veſicles flatten as ſoon as the Vaſcular are ſwelled; hence it follows that we can't maintain that the Air enters in the Veſſels by the Lungs. *Borelli* had Reaſon to ſay, that it was neceſſary an Animal ſhould have ſuch a Quantity of Air to give Oſcillation to the Parts; but he might ſay, that this Air entered with the Chyle through the lacteal Veſſels. *Sylvius*, who would maintain that Air carried a refreſhing Nitre into the Blood, had no other Reaſon for it than his own Opinion; we may ſay the ſame thing of *Lower*, who advanced, that the redneſs of the Blood proceeded from nothing but the Nitre of the Air; it is not extraordinary to ſee Opinions, thus badly grounded, ſpread about every where as Truths; this was undeſervedly held in great Eſteem. There are very few who, as ſoon as you aſk them whence proceeds the redneſs in the Blood, will not anſwer you that it is the Nitre of the Air which gives it that Tincture. But 1*ſt*, it muſt be proved that the Air is inſinuated into the Blood. 2*dly*, That it contains a nitrous Spirit; we have already ſeen if the firſt Opinion is well founded; as for the ſecond we can't doubt but that there are ſpread in the Air ſome nitrous Exhalations; but 1*ſt*, They are there but in a very little Quantity. 2*dly*, They are mixed with other ſaline and oily Subſtances. 3*dly*, Their nitrous Spirit is not well mixed. 4*thly*, We had as well expoſe the Earths which unite intimately to the nitrous Spirits of the Air; there are but certain Places where they imbibe. 5*thly*, Although we expoſe the Milk or a chylous Matter to the Air, there will be no red Colour there.

It is ſurpriſing that ſuch ingenious Men ſought for imaginary Reaſons; all Animals have Lungs, or ſomething like them. Butterflies, according to *Malpighi*, have ſometimes eighteen oblong Lungs which ſend their Tracheæ Arteriæ to the Circumference of the Body; if we ſtop their Orifices with ſome oily Subſtance, theſe Inſects die immediately with Convulſions. Worms have two Holes at the ſide of the *Anus* which are the Orifices of the Tracheæ Arteriæ, which continue laterally towards the Head, and ſend Branches towards the Viſcera of one ſide and the other. Lizards and Serpents have membranous Lungs compoſed of ſmall Veſicles, or ſmall Cellules, into which the Air enters; all the Difference between the Animals on the Subject of the Lungs is reduced to the Situation or Form; a Tortoiſe has its Lungs in the Belly; the Trachea Arteria pierces the Diaghragm, and forms one Heap, where we ſee Veſicles and Cellules which reſemble Rays of Honey; there are muſcular Strings to perform Expiration. Frogs have Lungs compoſed of two Lobes in the Form of a Cone; theſe Lobes are filled with Cellules which reſemble alſo the Rays of Honey: Fiſh which, except Dolphins, Whales, *&c.* have no Lungs, have nevertheleſs Organs reſembling them; we obſerve a ſort of Bronchia there compoſed of oblong Cartilages, like Leaves put one over the other, and fixed to a bony Baſis. Nature gave Fiſh this kind of Lungs, that they might attract and repel the Water and Air; but we can't ſay that Fiſh have any need of Reſpiration, for that the aerial Nitre entered into their Blood; thus we muſt ſeek for another uſe to Reſpiration.

The principal uſe of Reſpiration is to form the Blood; the Chyle comes immediately from the Heart to the Lungs; it has not received till then ſcarce any Change, but when it is inſinuated into the pulmonary Veſſels, it paſſes through the Filtres: The Globules of Oil which are in the Chyle are preſſed the one againſt the other, by this Preſſure they are fixed and form the Globules of Blood, ſuch as *Leewenhoeck* has obſerved; at laſt the Lymph becomes there more tenacious, and more proper to ſtop in the Parts which it muſt nouriſh, the other Uſes are reduced to the following. The Lungs ſerve 1*ſt*, For Deglutition. 2*dly*, To form the Voice. 3*dly*, To propel the Fæces out of the Body. 4*thly*, To make the Chyle advance in the lacteal Veſſels. 5*thly*, To carry odoriferous Bodies to the Nerves of the

Noſe. There are ſome who attribute to Reſpiration the refreſhing the Lungs, but it is evident that this cannot hold good in ſeveral Animals; in the Fiſh, for Example, it cannot, ſince their Blood is cold.

REMARK XLVI. *The Aſpera Arteria, or Windpipe.*

THE ſuperior part of the Trachea Arteria is thicker and more conſiderable, it is called Larynx; it is compoſed of many Cartilages. The firſt is the Cartilage Thyroides; it is a ſort of Buckler that has four Angles, the two ſuperior are long, and are fixed to the Horns of the Os Hyoides; the two inferior Angles are ſhorter; the Cartilage Cricoides is a Ring cut obliquely, the ſhorter part is the anterior Face of the Larynx under the Thyroide Cartilage, the longeſt Part is poſterior. The Arytænoide Cartilages are a Space of Triangle; they are ſupported by their Baſe, which is thicker than the reſt on the ſuperior part of the poſterior Portion of the Cricoide Cartilage; the Epiglottis which is pointy in Dogs, is not ſo in Men; it reſembles a Tongue, whoſe Extremity is very obtuſe, and arched within according to the Direction of its Axis. Theſe Pieces thus placed are united by Muſcles, by Ligaments and Membranes; the Duct they form is moveable, and can ſtraiten: let us examine the Muſcles that ſerve to give them Motion. 1*ſt*, There are two Muſcles which come from the Sternum and Clavicle, and are fix'd to the Cartilage Thyroides, their Contraction draws the Larynx downwards, and goes from the Epiglottis. 2*dly*, There are two which come from the Os Hyoides, and fix to the Cartilage Thyroides; they draw the Larynx upwards. 3*dly*, There riſe two Muſcles from the inferior poſterior part of the Cartilage Cricoides, which fix to the external Angle of the Baſis of every arytænoide Cartilage. *4thly*, It ſends two others from the lateral part of the Cartilage Cricoides under the Wing of the Thyroides, they are fixed to the Sides of the arytænoide Cartilages; they are the Antagoniſts of the precedent. *5thly*, From the hollow Cut of the Thyroide Cartilage at the Side it ſends two muſcular Plans covered with a Membrane; they fix to the arytænoide Cartilages. Theſe Muſcles are as Cords in the Duct of the Larynx, veſted with the ſame Membrane which lines the Larynx; they form a Groove which modifies the Air that goes out; perhaps the Sinuoſities that are at the ſide of that Groove contribute to it alſo; to theſe Muſcles which ſerve to move the Larynx, we may there add the muſcular Plan which goes from the Thyroide Cartilages to the Pharynx. *6thly*, From the lateral Part from above the ſuperior and poſterior Portion of the cricoide Cartilage, parts a muſcular Plan from every ſide, it fixes to the Point of the Cartilage Arytænoides, the one croſſes the other. *7thly*, In a Word, there are arytænoide, ſimple, tranſverſal Muſcles, which are join'd as Cartilages; we there obſerve ſome oblique Fibres. *8thly*, On the ſide of the Epiglottis there are fleſhy Fibres which are its Muſcles.

The Uſe of all theſe Muſcles is plain enough, as ſoon as we know their Situation, they are deſtin'd to enlarge, pull down, or to raiſe the Larynx: I will not enlarge thereon; thoſe that would read the uſe of theſe Parts, would underſtand nothing, if they knew not their Situation firſt; and thoſe who know the Situation and the Direction of the Fibres, have no need of a larger Detail; beſides, the uſe of the Muſcles can't be better obſerv'd, then in deſcribing their Inſertions, and Direction of their Fibres; for which we may look into Myology.

Sound is not produced but by a ſudden Compreſſion of the Particles of Air; this Compreſſion is made by Bodies, whoſe Parts being compreſs'd all at once, are immediately re-eſtabliſhed, and obliges the Air to ſtraiten; this happens for Example, when we ſtrike on a Clock, the Particles ſpreading, their Spring propels the Particles of Air which muſt neceſſarily bend, and attempting to return in the Place they were in before, ſtrike the Tympanum: In the Formation of the Voice it is not by the Colliſion of the two Bodies that the Air is moved; it is the Air itſelf, which puſhing againſt the Borders of the Glottis, is broken, and cauſes ſeveral Vibrations which form the Sound of the Voice.

In a Violin, in the Proportion that the Strings are thicker, longer, ſhorter, or more lax, the Sound muſt differ, for the Vibrations then are made with more or leſs Force and Swiftneſs; it is the ſame, according to ſome Authors, in the Organ of the Voice. When the Sides of the Glottis are more or leſs extended, and ſpread, the Vibrations they communicate to the Air, are, according to them, wholly different; but the ſtraitening only of the Glottis well extended varies the Tunes. The Air which comes from a very large Place paſſes ſwiftly into the Larynx; this Rapidity, with which it ſtrikes againſt the Glottis, cauſes Vibrations there: The ſtraiter the Orifice of the Glottis is, with more Rapidity the Air paſſes there, and the ſharper is the Sound. We ſee hence that thoſe who force themſelves to give their Voice a ſharp Sound, will at laſt be ſuffocated, if they continue it long, for as they almoſt entirely pull down the Glottis, but little Air can ruſh out; to them therefore happens the ſame thing as to thoſe whoſe Reſpiration is ſtop'd; but if we open the Orifice of the Glottis too much, the Air, which will ruſh out without Pain and without much Swiftneſs, will not break, and therefore there will be no Quiverings; hence it comes that thoſe who would give their Voice too grave a Sound, can give none at all. Let us examine the mechanical Law by which the Voice is formed.

The Trachea Arteria has been compared to a Flute; it was believed that it contributed to Sound, the ſame as the Tubes of Inſtruments to the Wind, but we ſpeak not but in ſtriking the Air; it was neceſſary there ſhould be ſome Difference between the Flute and the Trachea Arteria, when we were about to ſpeak of the Air which is thrown into the Lungs. Another conſiderable Difference which is between the Tube of a Flute and that of the Lungs, is that the Air paſſes in the Flute with an extraordinary Rapidity, whereas the Air iſſues out very ſlowly when we ſing, and ſuffers no Violence till it is come to the Glottis.

The Air which comes ſlowly from the Lungs paſſes with Violence through the Groove of the Glottis, becauſe from a large Space it goes to a narrow one; this therefore is the true Place where the Sound is formed; the Space of the Mouth and Noſtrils contribute nothing to the producing of it, but gives it different Seaſonings; we may ſee it by the Alteration of the Voice in Rheums, or when the Noſe is ſtop'd.

Sound, of which we have been ſpeaking, forms the Speech and Tunes, whoſe Variety offers ſo many Pleaſures to the Ear; firſt let us ſee in what conſiſts Speech, and why Man is almoſt the only Animal that has the Gift of Speaking.

A certain eminent Philoſopher told me one Day, ſpeaking of the Voice, that he could not comprehend what was the Difference of the Letter A and Letter B pronounced on the ſame Tune; for, ſaid he, Tunes differ not in themſelves, but by the Celerity of the Vibrations of the Air, for A and B are by Suppoſition on the ſame Tune, how can they therefore ſtrike the Ear differently?

It is certain that we can't ſuppoſe that the Difference of theſe two Letters pronounced in the ſame Tune proceeds from more or leſs Motion, ſince we may pronounce them with the ſame Force on *Sol* or *Fa*; but it is evident that the Air diverſly reflected muſt vary the ſame Tunes; it is theſe Modifications that the Mouth gives to the Air which cauſe all the Differences in the Pronunciation of the Vowels.

There are ſeveral Inſtruments ſubſervient to Speech, the Tongue is the principal, as known by all; the Lips and Teeth contribute to it very much, Experience demonſtrates it in thoſe who have loſt their Teeth, or in thoſe who have ill-ſhap'd Lips; the Palate is alſo of great Uſe to articulate; thoſe who have it not, talk indiſtinctly.

Let us come to the ſecond Queſtion, *viz.* whence comes it that the greateſt part of Animals can't have the Uſe of Speech? We might believe at firſt there was ſome Inſtrument abſolutely neceſſary to it, wanting; but we ſhould be miſtaken, if we had any ſuch Ideas; except the Palate, they have all that is neceſſary for Speech; it is true, that in ſome the Tongue is not figur'd as it ſhould be for that Purpoſe; its pointed Figure is an Hindrance to Mag-Pies, who pronounce well enough, if the Point of their Tongue is cut. What I ſay concerning Animals is ſo true, that

Dogs and Cats have been made to ſpeak, in giving their Gullet a certain Configuration in the time that they bark and mew; this muſt not appear ſurpriſing, ſince we have been able to make a Machine whoſe Springs were certainly leſs looſen'd than thoſe of Animals which we have been ſpeaking of, pronounce a pretty long Sentence.

What is it therefore that hinders Animals from ſpeaking? It is that there is no Being in them which knows how to make uſe of their Organs; there are ſome who, by the Strength of Repetitions, accuſtom themſelves to pronounce ſome Words, but they retain but a very ſmall Number. Parrots have a round Tongue, and therefore it is that they pronounce better than other Birds; hence we ſee why we are obliged to cut the Point of the Mag-Pie's Tongue, that it may pronounce ſome Words.

As the Pronunciation of every Letter requires a different Configuration of the Lips, we may make our ſelves underſtood by the Motion only of our Lips to deaf and dumb People; I have ſeen many Examples of it. If the Tongue of a dumb Man is not ill diſpoſed ſince his Birth, we might make him ſpeak. *Conrad Aman* gave us a famous Example of it in a *Dutch* Girl who was born dumb and deaf; he made her ſpeak, taught her the *Latin* and *Dutch*, and made her capable of diſputing, by ſeeing the Motion of the Lips of thoſe who talk'd with her.

After having treated about Speech, let us come to Singing, and ſee of what Uſe the Cavity of the Mouth is. We have already ſaid that contributes to Sound, but this Sound conſiſts not in a ſimple Reflection, it is a Sound always proportioned to the Tones which are formed in the Glottis; for in raiſed Tones this Cavity ſhortens, and in the low Tones it lengthens; this Lengthening and Abridgment of the Larynx which never reſts in the ſame Situation in the Inflexions of the Voice, how inſenſible ſoever they may be. But doth the lengthening and ſhortening of the Mouth ſerve to form Tones the ſame as certain Inſtruments whoſe Tones depend on the length of the Tube? No; the ſmall Extenſion of the Mouth, which at moſt is but ſix Inches, can't put a Voice in the Uniſon of a Tube of a certain Extenſion; nevertheleſs we ſee that a deep baſe Voice can go till the Uniſon of a Tube of eight Feet long; all Tunes come from the Glottis, which we can't compare but with Inſtruments, whoſe Tones depend not on the Dimenſions of their Tubes, but only of the Reed.

The Glottis has been compared to the Reed of an Hautboy, but what we have been ſpeaking of ſhews us upon what Foundation this is ſupported; the Reed of the Hautboy produces the Sound, but it is the Dimenſions of the Inſtrument which form the Tunes. I ſhall not run over other Inſtruments to ſhew in what they differ from the Glottis; I ſhall content my ſelf to ſay, that there is nothing which has more likeneſs to this Groove of the Larynx, than the Interval in a bad Frame joined to the Gap of a Window; the Wind that paſſes through this Interſtice produces there a Sound, by the ſame Mechaniſm that it produces the Voice. But what Difference is there between theſe two Inſtruments in regard of their Effects? all human Induſtry can't draw an agreeable Sound from the Frame of a Window; but the Glottis is a Source of Modulations which charm our Senſes; theſe are the Cauſes that make their Effects different. 1*ſt*, The Air which puſhes the Frame of a Window, can't be moderated in its Motions, while that which is puſhed into the Glottis, finds Inſtruments ready to give it Swiftneſs or Slowneſs as the

Tune requires it. 2*dly*, There is on the Glottis a little Tongue called Epiglottis, which by its different Vibrations can give many Modifications to the Air; the arytænoide Cartilages that are turned on the Glottis, can produce a like Effect by the divers Motions which they are capable of; hence we ſee that there is ſome Difference between the Structure of the grinding Frame and the Glottis, which we may look upon as an Inſtrument to the little Tongue. 3*dly*, The Mouth modifies, augments, and temperates the Sound, according to the Proportions it always obſerves in ſhortening; the like Inſtruments are not found in the Frame, therefore the Effect muſt be very different.

The Glottis is formed by two Muſcles which run parallel from the thyroide Cartilage, and join each to the arytænoide Cartilage which anſwers to it; theſe Muſcles, which are cloathed with a Membrane, leave between them an Interval called the Glottis; this Interval may enlarge and ſtraiten poſteriourly by the Motions only of the arytænoide Cartilages; it is this Straitening, or this Widening which produces the Difference of Tunes; this is perceived in Singing, is taken notice of in Inſtruments, and is confirmed by Philoſophy. This ſtraitening and widening of the Glottis affords us a wonderful Phænomenon; the opening of the Reed of a Baſſoon ſtopt up, is at fartheſt but of a Line, and that of a Hautboy ſtopt up but of half a Line: Upon this we may ſuppoſe that the Orifice of the Glottis above is of half a Line, and that of a Baſs of one Line; how many Subdiviſions ſuffers not this little Space in forming all the Differences of the Tunes? according to the Calculation made, the Glottis forms more than 9632 Subdiviſions. To ſhew an Example of the Promptitude and Exactneſs of the Glottis, we have nothing to do but to place two Strings to the perfect Uniſon on a Monochord; for if we ſhorten one of theſe Cords of a two thouſandth Part, the Ear immediately perceives the Diſcord, and the Voice, which was at the Uniſon of two Strings, will tune immediately the Sound of that which is ſhortened, for this Difference is reduced to the $\frac{1}{196}$th Part of a Tune: This is a Part of the Wonders of Voice; let us examine the Particulars of the Glottis.

If it ſhould happen that the Reed of an Inſtrument were very lax, no Sound could be there formed; the Reaſon of it is, becauſe Sound proceeds from nothing but the Vibrations: a lax Body can't cauſe any Vibrations in the Air; this Relaxation may come from the Humidity which raiſes their Spring to the Parts of the Tube; hence we ſee, that if the Glottis were to relax by the Fluids which moiſten it, the Voice would be loſt the ſame as if it opened extraordinarily by ſome Accident, if it dried in ſuch manner that it would be no more flexible. We ſee that Diſorders would happen in the Voice; as ſoon as the Lips are not moiſtened by the Saliva we can't ſo eaſily whiſtle, becauſe the Lips being dry can't be well adjuſted; it is the ſame in the Glottis: Beſides, when the Surfaces of a Body are dry, the Air which puſhes againſt them ſlides too eaſily; thus it is neceſſary for a little Humidity to ſtop it, ſo that it can puſh againſt the Parts which it meets.

To the end that the Voice may be eaſily formed, it is neceſſary, 1*ſt*, for Suppleneſs in the Muſcles which open and ſhut the Glottis; if they became paralytick, no Sound would be any longer form'd. 2*dly*, The Ligaments which unite the Pieces of the Larynx muſt eaſily obey. 3*dly*, There muſt continually be a Fluid there to moiſten

ten the Larynx; perhaps the oily Juice of the Thyroide Gland, expreſs'd by the Muſcles called *Sternothyroideal*, contributes to render the internal Surface of the Larynx ſmooth, and conſequently more fit for the forming of the Voice. *4thly*, The Noſe muſt not be ſtop'd, otherwiſe the Air which is reflected diverſly modified in the bottom of the Mouth that conducts to the Noſe, forms a diſagreeable Sound; we call that Speaking thro' the Noſe, but *Mal a-propos*, for then all the Air paſſes through the Mouth, and the Noſe that is ſtop'd receives but little, if any at all. *5thly*, It is neceſſary the Thorax ſhould have a conſiderable Dilatation, for if the Lungs can't extend well, we ſhould be forced to breathe every Moment; thus the Voice would fall, or would be interrupted diſagreeably.

Laughter.

When we have any thing joyful in our Mind, immediately it appears upon our Countenance, and when we are agreeably ſurprized by ſomething, we ſhew it by Laughter: we can't explain how at the Occaſion of an Idea this Motion is produced in the Lips and whole Face, nor muſt we ever hope to attain it; there are ſome Phænomena which we may explain more eaſily. *1ſt*, As ſoon as we are ſtruck by ſome pleaſant or ridiculous Idea, we laugh heartily; the Breaſt is ſtraitened and becomes immoveable, the Larynx at the ſame time is compreſs'd, the Diaphragm acts by little Jerks, and lets the Air go out Impetuoſly. *2dly*, As there is a Connexion between the Diaphragm, the Muſcles of the Face and of the Larynx by means of the Nerves, we muſt not be ſurpriz'd if the Motions of the Diaphragm are perceived in the Face and Larynx. *3dly*, Since the Lungs are compreſs'd in Expiration, we ſee at the time that we laugh, the Blood muſt not paſs freely in Veſſels of the Lungs; thus Circulation is performed with Difficulty. *4thly*, Laughter degenerates ſometimes into Convulſions; this is not ſurpriſing, ſince in itſelf it is nothing but a kind of Convulſion, the Diaphragm being violently moved, by the means of the Intercoſtal of the eighth Pair, and diaphragmatic Nerves, cauſe Convulſions in the Muſcles with which theſe Nerves communicate directly or indirectly. *5thly*, When we laugh, the jugular Veins ſwell the ſame as the Head; this proceeds becauſe the Nerves which have a Connexion with the Diaphragm environ theſe Veſſels; as for the Head it of Neceſſity becomes ſwelled, ſince the Blood, no more than the Serum, can then be diſcharged into the Veins. *6thly*, It often happens that in laughing we ſtop Reſpiration; this muſt happen when the Motions continue long and with Violence in the Diaphragm. *7thly*, When we laugh long and with great Force, the pulmonary Veſſels may poſſibly break by the Compreſſion of the Diaphragm; we have alſo ſeen ſpittings of Blood ſucceed theſe violent Motions. *8thly*, The Apoplexy proceeds from nothing but a Stoppage of the Blood. In the ſecond Article we ſaid, that the Blood paſſed not freely in the pulmonary Veſſels, it is poſſible therefore an Apoplexy might follow the violent Motions which agitate the Diaphragm, when we laugh. *9thly*, If when we laugh to exceſs we may be troubled, the contrary happens when we laugh moderately; every where the Motions which happen then in different Places, the Blood divides, the Veſſels which had not Force enough to propel the Humours are preſs'd, many Parts which were without Strength are agitated, and receive more Blood, the Humours are propel'd into the ſecretory Pores, Tranſpiration augments, *&c.*

Cough.

If any thing troubles the Lungs a Motion is excited called Cough, it is performed by the Means of the Organs of Reſpiration. 1*ſt*, The Air having entered by Inſpiration is retained ſome time; it is the Irritation we perceive in the Lungs which cauſes the retarding for a Moment Expiration, to endeavour to expel that which incommodes the Lungs; then the Muſcles of the Abdomen enter into Contraction, their Motion puſhes the Diaphragm with Force, the Lungs, violently preſs'd by different Motions, are emptied of the Air which they contain; by theſe Motions the Air, puſh'd againſt the Larynx, forms a Sound. When I ſaid that we retard Expiration for a Moment, to expel that which incommodes the Lungs, I did not pretend that this was always voluntary, I would explain nothing but Cough which is free; when there is ſome violent Irritation in the Lungs, there happen Convulſions in the Diaphragm that form a Cough, which we are not Maſters enough to ſtop. 2*dly*, When the Air goes out with Force, the Subſtances that incommode the Lungs are taken away, when they are found at its Paſſage, and that they can follow its Motions; it happens alſo, that the diverſe Motions that the Lungs then receive, make the Liquors ſtop'd in ſome Strainers where they caus'd Irritation, flow out; it may be again that the Blood or Lympha ſtop'd which can irritate the Nerves by their Sharpneſs, retake their Motion by the Agitation of the Texture of the Lungs; nevertheleſs, if the Cough continues a great while, far from making the Juices flow, it contributes to ſtop them, for in thoſe violent Motions with which it agitates the Lungs, the Veſſels and Strainers dilate much, the Blood which can't circulate freely, no more than when we laugh, forms at laſt theſe Veſicles which we find in the Lungs of Phthyſics. *3dly*, We obſerve that when we laugh much, we Cough; this is a mechanical Series of Motions excited then in the Lungs; during the time of Laughter the Blood does not circulate freely, as we have remark'd; it is extremely preſs'd in its Veſſels by the different Motions of which we have been ſpeaking; this can't be done but the Nerves which are in the Subſtance of the Lungs muſt be irritated; we muſt not therefore be ſurpris'd, if there follows a Cough; beſides, there is no great Difference between the Action by which we laugh, and that by which we cough, the one and the other depend but upon the Air which goes out by different reiterated Motions. They differ not 1*ſt*, but in that, the Motions are more violent in a Cough; 2*dly*, In that they are not greatly interrupted in laughing, whereas they are very much ſo in coughing. *3dly*, In that we open the Larynx more when we cough, the Thyroide Cartilage bends down, and by that means the Epiglottis by its Point is far from the Arytænoide Cartilages; in a Word, we place the Larynx in the Situation where it is, when we expire very much: We ſee by that the Noiſe of the Cough muſt be ſoft ſometimes; but if the Cough is violent, then the Air which will paſs through the Glottis will there excite a Sound, which will be ſtrong, and then the Thyroide Cartilage will not deſcend; the ſoft Noiſe of which we have been ſpeaking, is as that of aſthmatic People, who reſpire with great Pain, and who then pull back the Angles of the Mouth, as when we would laugh. By the ſame Reaſon that we cough after having laugh'd, we may cough after having ſung, cried, talked a great while, the Blood which flows not well, irritates the Lungs. *4thly*, The diſordered Motions which happen to the Stomach, often produce Cough; we ſee at firſt that this muſt be ſo, becauſe the *par Vagum* gives Ramifications to the Lungs and Œſophagus: when there happens an Irritation in the one, it will be perceived in the other; we have alſo obſerved, that an obſtinate Cough has often produced Vomitings.

Sneezing.

Sneezing is alſo performed by the Organs of Reſpiration. *1ſt*, There is a Ramification of Nerves from the fifth Pair, which parts from the Union of the ſixth; this Ramification runs to the pituitary Membrane of the Noſe. *2dly*, When this Nerve is irritated, the Intercoſtal, *par Vagum*, and conſequently the Nerves of the Muſcles which ſerve Reſpiration, muſt perceive this Irritation. *3dly*, The Nerves of the Muſcles which ſerve Inſpiration being irritated, it is neceſſary that theſe Muſcles enter into Contraction. *4thly*, As the Nerves of the Noſe are very ſenſible, they produce great Motions in the Nerves which go to the inſpiratory Muſcles, it is this makes the Thorax dilate all at once in an extraordinary manner. *5thly*, This ſudden Dilatation might be followed with a ſoft ſtraitning; it would be ſo, if the Muſcles which ſerve Expiration had no Nerves irritated, the ſame as thoſe of the inſpiratory Muſcles; as theſe inſpiratory Muſcles are ſtronger than the expiratory, their Action has immediately prevailed; but that during the time they act the Reſiſtance augments, and the Nerves of the expiratory Muſcles being always irritated, cauſe a Contraction there which carries it at laſt on the inſpiratory Muſcles. *6thly*, The Violence with which the expiratory Muſcles are contracted, compreſſes in an extraordinary manner the Lungs; hence the Air is obliged to iſſue out with Violence. *7thly*, By the Communication of Nerves, the Muſcles which ſerve to raiſe the Root of the Tongue, enter alſo into Contraction; hence the Air can't ruſh out through the Mouth, but it is thrown impetuouſly in the Cavity of the Noſtrils; and if the mucous Matter which is filtrated in the pituitary Membrane is heaped up in its Reſervoirs, the Motions of the Air are raiſed and make it go out. *8thly*, The Muſcles which puſh the Air of the Lungs in the Trachea Arteria are the Muſcles of the Abdomen and Diaphragm; ſince it relaxes in Expiration, it is of no great uſe there, it is the tranſverſal Muſcle of the Abdomen particularly that acts; we alſo ſee that the Epigaſtrum is conſiderably ſunk.

Yawning.

Yawning is again a Phænomenon of Reſpiration, which can't be explained in a ſatisfactory manner. *1ſt*, When we yawn, almoſt all the Muſcles on which the Will acts are put into Contraction. *2dly*, During the yawning the Cavity of the Thorax augments, and the Air enters by Degrees. *3dly*, When the Muſcles have been drawn during ſome time, there then will follow a violent ſhooting. *4thly*, To this ſhooting will be joined a ſtrong Inſpiration, which finiſhes all theſe Motions. *5thly*, Yawning is voluntary, ſince we can occaſion the ſtrong Inſpiration in drawing the Muſcles of the Face, and the others which concur to the Yawning. *6thly*, It is alſo involuntary, ſince there are Caſes where we can't help yawning.

Duncan ſays, that Yawning was occaſioned by the Œſophagus, but he only gave Conjectures, which ſeem not well founded. Others have ſaid, that Yawning was performed when the Blood circulated not enough; this is true: When we are preſs'd by Sleep, or an attack of a Fever approaches, we yawn much, it is certain that then Circulation is not free. Sleep proceeds from nothing but the Nerves which are not extended enough, then the Veſſels fall down, and permit not the Blood ſo free a Paſſage. In a Fever their capillary Extremities are obſtructed by a viſcous Matter, this Obſtruction is an Obſtacle to Circulation; but here we muſt tell why Yawning muſt happen, when the Circulation finds ſomething that ſtops it. There is a Philoſopher who pretended to explain this in the following manner. When the Blood is not free, ſaid he, we feel a Trouble which finiſhes not, but when the Blood finds a Paſſage without any Obſtacle, then we ſeek that which can make the Fluids of our Body circulate; the ſame as when the Stomach is empty, we ſeek to ſatisfy the Perception of Hunger which preſſes us; for one of the Means to make the Blood circulate is, 1*ſt*, To contract the Muſcles. 2*dly*, To empty the Veins; we contract theſe as ſoon as the Muſcles of the Face and Larynx; this Extenſion compreſſes the Veſſels, but the Muſcles of the Face and Larynx can't be in violent Action, but the Nerves of the Larynx which communicate with thoſe that run to the inſpiratory Muſcles, are agitated; this Agitation at laſt cauſes a ſtrong Inſpiration, which in making a great quantity of Blood enter into the Lungs, empties the Veins, and by that renders the Circulation more free. This Opinion explains not how we are forced frequently to yawn even againſt our will. After having ſpoke of the Larynx, we muſt proceed to its continuation, which is the Trachea Arteria; it is a Duct compoſed of cartilaginous Segments, which are interrupted towards the Poſterior part by a ligamentary Membrane, which is ſtrong: Theſe Segments are joined the one to the other by a muſcular tye, as *Morgagni* has obſerved it. This Duct divides into two towards the fourth Vertebra of the Back; the Interruption of the cartilaginous Rings is ſeen in theſe two Diviſions the ſame as in the Trunk; but at laſt in the Ramifications which are in the Lungs, the Duct is no more interrupted, as *Jaſpar Bartholin* obſerved. We however do not mean to ſay that all the Rings are compleat, but that many Segments form a Ring. *Diemerbroek* ſeems to be the firſt who mentioned it; at laſt theſe little Ducts become membranous, and form ſmall Bags, which are Bronchial Veſicles; the Tunics, at the Place where the great Trunk is interrupted, are fortified by Plans of muſcular Fibres, that ſtraiten the Rings by their Contraction, as *Jaſpar Bartholin* obſerved. The Glands on the external Membrane, open into the Cavity of the Trachea Arteria; *Morgagni* gave a fine Figure where the Orifices of theſe Glands were well engraved.

The Heart.

THE Heart is a hollow Muſcle, encloſ'd in a Bag placed on the Diaphragm, ſituated in the Cavity of the Mediaſtinum, having at its ſide the two pulmonary Lobes. We muſt conſider its Baſe, Body, and Point: at its Baſe are two Bags tyed one againſt another; they have each of them an Appendix which we call Auricle; they are covered within with a very fine Membrane that covers the Heart alſo; we find at laſt fleſhy Columns which are the Muſcles that make the Blood paſs into the Heart; then comes an internal thin Membrane, the Appendices have the ſame Structure. Theſe Bags come from two tendinous unequal Circles, which are at the Orifice of the Ventricles, the left is leſs than the right; from its Angles run the Veins which carry back the Blood of the Lungs, the right one receives the Vena Cava, whoſe Trunk is ſomewhat fleſhy; in the Place where thoſe two Bags unite we ſee an Orifice in the Fœtus; this Hole permits the Blood to paſs from the right to the left Bag; but the Fluids that come from the left Bag, can't flow back into the right one; from the Lips of the inferior Arc of that Trunk a double Membrane is raiſed, which in the left Bag forms a Creſcent; the Points of the Creſcent are raiſed by degrees ſo well, that the Partition may entirely ſhut the Hole; this Membrane yields to the Blood which comes from the right Bag, but applied on the Hole it ſtops the Blood which comes on the left ſide the ſame as a Valve; this is the Baſis of the Heart; let us come to its Body, which is compoſed of muſcular Fibres. *Lower* has deſcribed them, but the Deſcription is deficient. Before we give it we muſt obſerve that the Body of the Heart, whoſe Figure is Conic, contains two Cavities, one that anſwers to the Vena Cava, and another to the pulmonary Veins. That which anſwers to the Vena Cava, is very large in the Fœtus, while the left Cavity is very ſtrait; it is even larger in an Adult than the other. In Animals theſe two Ventricles or Cavities are one lower than the other, but in Man it is not ſo; every Cavity is extended. By muſcular Columns, which are ends of Fibres that form the Body of the Heart, the Blood enters there, by an Orifice which anſwers to the Vagi; at the opening on the left ſide there are two Valves, called Mitrales; at the entry of the right Ventricle there are three called Tricuſpidales, they open within the Heart, but they can't yield, when the contracted Ventricles propel the Blood againſt them; there are Strings that come from the Veſicles, and are fixed to the Valvules at the Surface that regards the bottom of the Ventricles; thus they can't be raiſed but as much as is neceſſary to hinder the reflux of the Blood; at the Orifice of the Arteries there are alſo Valves, but their Structure is very different; they reſemble Pigeons Neſts, they have two Slits, one on each ſide, with a Riſing in the middle. *Morgagni* gave us a fine Delineation of it.

When theſe Pigeons Neſts are puſhed by the Blood that comes from the Ventricles they are raiſed, and give it paſſage, but when that Blood has paſſed in the Artery, it can't flow back again, becauſe its Paniers are filled, and applied one to the other. This is a Deſcription of the internal Parts of the Heart; let us ſee the Deſcription *Lower* gives it from the Direction of the Fibres. Theſe Fibres, ſays he, part from four orbicular Tendons that environ the Orifices of the Ventricles and return there for the moſt part. 1*ſt*, There are ſome of them that are ſtrait, and come from the Baſis to the Point on the right Ventricle, to ſhut it in Contraction. 2*dly*, There are thoſe that aſcend obliquely from the left to the right, and terminate at the Baſis; they imitate the Circumvolutions of a Screw. *3dly*, On the Precedent there are others found that going from the left to the right, embrace the two Ventricles, and are raiſed towards the Baſis of the left ſide; theſe Fibres compreſs both Ventricles, and approach the Point of the Baſis; thoſe of the ſecond Article, which are alſo common to the two Ventricles, concur with the Action of thoſe. *4thly*, There is another Plan of Fibres which are fixed to the two precedent Rows in their different tours, and which pull them down. *5thly*, The left Ventricle has two Rows of Fibres which are peculiar to it; the external Plan which is under the Fibres we have been ſpeaking of, forms a Spiral that mounts from the left to the right, and which partly forms the Partition; it terminates at the Baſis, there are other Fibres like thoſe in Number 4. which are there joined. *6thly*, In a word, the laſt Plan deſcends obliquely from the Baſis of the left to the right, and forms the internal Part of the Ventricle, and finiſhes the Partition. Theſe are the Directions of the Fibres, according to the Deſcription of *Lower*, but we muſt thereon correct many Things. I ſhall not much enlarge upon this, becauſe it is impoſſible to give an Idea of theſe Fibres without ſhewing them. I ſhall content my ſelf to ſay, that the common Fibres firſt run from the right to the left, and then from the left to the right. *2dly*, The Fibres that compoſe the two Ventricles exteriourly, cover other Fibres, whoſe Plans in proportion as they are interior, loſe their Obliquity.

The Fibres that compoſe the Heart, come from the Nerves of the 8th pair, that come in great quantity from between the pulmonary Artery and Aorta, to expand at laſt in the extent that the ſubſtance of the Heart and Auricles occupy; in this Space they form the four Cavities, and are the Baſis of the muſcular Fibres which compoſe the ſubſtance of the Heart.

There are in the Heart proper Veſſels, the ſame as in the other Parts of the Body; the Aorta being arrived above the two anterior Valves, ſends ordinarily two Ramifications, that by an oppoſite way, form a Canal fixed to the Circumference of the Baſis of the Heart, hence deſcend Ramifications that extend through all the Subſtance of the Heart with the Veins that anſwer them; we muſt nevertheleſs remark, that the Veins are more external and inoſculate more ſenſibly. After having ſpoke of the Structure of the Heart, we muſt ſpeak of the Structure of the Veſſels that iſſue out thence; this is neceſſary to explain the Circulation of the Blood.

The Structure of the Arteries.

The Arteries are Conic Tubes that run in many Directions; the Ramifications come from their Trunk at acute Angles; generally we never find thoſe that form right Angles, as the Intercoſtals; the Arteries are compoſed of five Coats; the external is very thin; it is nervous in its exterior Surface, but internally it is nothing but a Network of Arteries that come from the Coronary, there are Veins that anſwer them; the ſecond Coat is cellular and thin, capable of Dilatation, becauſe theſe Cellules may ſwell; it is *Ruyſch* diſcovered this Coat; the third is glandular; and the fourth is nothing but a texture of muſcular, annular, and very ſtraitened Fibres, diviſible into many Lamina; the fifth, which is that which immediately forms the Cavity, is membranous, thin, and compoſed of longitudinal Fibres that can contract. The Veſſels compoſed of theſe Coats become always leſs, in proportion as they are diſtant from their Origin; in different Diſtances, their Orifices, Diviſions, Intermixture, the thickneſs of their Membranes vary very much; in a word, their Ramifications become inviſible; we have much diſputed on their continuity with the Veins, upon that we made Injections which ſeem to prove it; but it is always certain that in the Spleen, the Penis, the ſpongy Texture of the Urethra, the Sinus's that are on the ſide of the Saddle, they are not continued with the Veins; it may be that the ſame Thing is in the other Parts of the Body. What regards the ſecretory Veſſels, it is aſſured that there are thoſe that are nothing but a Diviſion of the laſt Ramificat i ons, which form a ſort of Pencil by an heaping together of new Ramifications made by that Diviſion; as theſe laſt Ducts are very ſtrait, there is nothing but the ſerous Part that can exhale, perhaps alſo the Arteries are terminated by a glandular Pulp, as M. *Boerhaave* inſinuates. We muſt not apprehend, as *Pitcairn*, that this Structure will be an hindrance to the Circulation; this Reaſon is ſufficient if we ſay that the Blood circulates in the Spleen. If it is difficult to find the laſt Ramifications of Arteries, there is no difficulty to carry them on to the ſide of the Heart; they all join to the Aorta or pulmonary Artery: Thoſe that are expanded throughout the Body go to the Aorta; thoſe that compoſe the ſubſtance of the Lungs are thrown into the pulmonary Artery, except the bronchial Artery. After having ſeen the Structure of the Artery let us examine its Action; this is neceſſary to explain Circulation.

The Action of the Arteries.

1*ſt*, The Arteries being ſwelled act on the Matter that fills them, they preſs ſtrongly the Finger, when we introduce it into their Cavity, and they ſtraiten when we have taken it away; they are always full in a living Animal, but in Carcaſſes they are empty; it is neceſſary then by their Action they had propelled the Blood in the Veins; they make the Air that was blown in there ruſh out with Violence: and if in a Dog we tie the Aorta near the Heart, the Blood continues to paſs into the Veins in ſuch a manner that the Arteries are emptied entirely; when they are ſtraitened they are ſtill: the Force that makes the Arteries contract depends on the nature of elaſtic Fibres, muſcular Plans, and Veſſels filled that form the arterial Membranes. 2*dly*, The Blood that is there propelled by the Heart, muſt overpower 1*ſt*, the Force which we have been ſpeaking of. 2*dly*, The Reſiſtance that it finds in the Curvatures, for the leſs the Angle that forms the Artery is, the greater Force is required to propel a Fluid there, as we ſhall plainly ſee, if we have any Idea of Motion and its Rules. 3*dly*, It is neceſſary that the Blood ſurmount the Preſſure of the external Bodies of the Air; for example, the Motion which remains in it, after having removed theſe hindrances, is preciſely the Force with which it flows; hence we ſee, that it muſt enter into the Lungs with leſs reſiſtance. 4*thly*, It is neceſſary that the Blood that ruſhes from the Heart, ſurmounts the reſiſtance of that which comes before it; hence it follows that the force of the Heart muſt be very great, as we ſhall ſee elſewhere. 5*thly*, When the Blood propelled by the Heart fills the Arteries, their Diameters become neceſſarily longer. This

Dilatation was by the *Greeks* called *Diaſtole*; it is performed, as we ſee, in the time that the Heart enters into Contraction, ſince it happens during the Blood's being propelled into their Cavity: If it were neceſſary that the Blood that comes from the Heart might paſs thro' the Arteries to ſwell them, the *Diaſtole* would not happen in the ſame time thro' the whole Body; but becauſe there is Blood found in the Arteries, all their extent muſt dilate in the ſame time, at leaſt the Difference will not be perceivable; the Dilatation will not be felt much in the fleſhy Places, becauſe Fleſh yields eaſily on all ſides; but if the Artery creeps over the Bone, then all the Effort will be perceived at the oppoſed Part, becauſe the Bone can't yield. *6thly*, As ſoon as the Heart will ceaſe propelling the Blood into the Arteries, they'll neceſſarily act on the Blood by their elaſtic and muſcular Force; and aided by the external preſſure of the Air they'll ſtraiten; this ſtraitning has been called Syſtole by the *Greeks*. Theſe two oppoſite Motions that happen, the one during the Contraction, the other during the Dilatation of the Heart, is that which is called the Pulſe; let us examine its Phænomena.

The Pulſe.

The firſt Thing that is preſented, is the infinite Differences that the Antients obſerved in the Pulſe; *Galen* and *Paul Æginetus* multiplied them in ſuch a manner, that it ſeems their Imagination had a greater ſhare there than their Experience; to be convinced of it, we have nothing to do but obſerve that which may produce in the Arteries the Impreſſions of the Blood ſwelled by the Heart.

1*ſt*, If the Arteries had many Springs in ſuch a manner that they propel immediately with facility the Blood into the Heart. 2*dly*, If the Heart at every Contraction does propel much Blood, it will happen neceſſarily from theſe two Things that the Partitions of the Arteries will ſpread much from their Center, *i.e.* that they will ſwell very much, we ſay then that the Pulſe is ſtrong: We plainly ſee that this Pulſe marks the fullneſs of the Blood, ſince the Artery is filled much, the force of the Heart augments, for it propels much Blood, and makes the arterial Partitions run conſiderably back; the free Action of the Artery that can contract and dilate eaſily, the Defect of the Obſtruction that hinders the Blood from paſſing into the Veins, and keep the Arteries always ſwelled, the liberty of the Tubes that ſeparate the ſuperfluous Humours, which otherwiſe would ſwell the Arteries in ſuch a manner that they could not contract nor dilate much; but if the Pulſe is weak, all this muſt be different.

2*dly*, If the Heart has much force, the Partitions of the Arteries will be vehemently propelled; we call that a ſtrong Pulſe, we ſee that it can be in the ſame time great, for the arterial Partitions may go a large Way with force. This Pulſe marks a great Action in the Nerves, and conſequently in the Heart which receives their Impreſſions; the abundance of Blood, ſince a little Quantity can't give a great Motion to the Arteries, the liberty of the Circulation and Secretions, provided it be not too frequent; hence it follows that this Pulſe is a good ſign, when it is found in all the Body; it deceives in the apoplectic Maladies, and in others where the Circulation is free thro' the Cerebellum, embaraſſed in other Places, and eſpecially in the Viſcera:

The weak Pulſe marks the contrary; but it deceives alſo in fat Subjects; for the Arteries being very much ſunk, the Reſiſtance is a great deal greater, and thus the force of the Heart can be leſs perceived.

3*dly*, If the Partitions of the Heart employ little time to be diſtant from their Center, we ſay then that the Pulſe is ſwift; it is impoſſible to diſtinguiſh this ſort of Pulſe; for in the natural ſtate the Partitions employ but a very ſhort time to be diſtant from the Center; therefore in the unnatural ſtate the Difference can't be perceivable. If there happens an univerſal Obſtruction in the capillary Extremities, then the Blood which can't go from the Arteries will keep the Partitions in dilatation a great deal longer; thus the Arteries will be a longer time a ſtraitning, this Pulſe will be ſlow; on the contrary, if there were ſcarce any Blood in the Arteries, this Blood propelled would not a long time preſs the Partitions, it would do nothing, if I may ſo ſay, but touch them: this Pulſe may be called a ſwift Pulſe; the ſlowneſs of the Pulſe might be occaſioned by the viſcous Matter of the Blood which then could not flow, and would longer preſs the Artery.

4*thly*, The hard Pulſe is that which makes us perceive a great reſiſtance in the Artery; it may be occaſioned by the drineſs of the Arteries, which receiving no great Nouriſhment, ſtraiten and become hard, by the fulneſs of the Arteries in which the Blood, if it is much preſſed, yields not, by the Inflammations that happen to the capillary Extremities; for 1*ſt*, the Fluids that can't well circulate in the Partitions of the Arteries, make them hard. 2*dly*, Hence the Arteries ſwell, we may by the ſame Reaſon ſee that if the Secretions are not performed as they ought, the

Arteries will ſwell, and will reſiſt the Finger that will preſs them.

5thly, The Pulſe is frequent when there is a ſmall Interval between the two Pulſes. To explain well how it is formed, we muſt ſuppoſe two or three Principals. *1ſt*, When a Body acts on the Fibres of the human Body, the Vibrations of the Fibres become ſtronger, becauſe the Reaction is equal to the Action. *2dly*, When the Blood is propelled with force in the Arteries which are very ſmall, their Diameter augments; thus Pulſation which was not perceivable will then be perceived there. *3dly*, The ſame as the Heart acts on the Arteries, the Arteries act reciprocally on the Heart; for their Blood is propelled by their Contraction towards the Heart the ſame as towards the capillary Extremities; a lateral Motion propels not a Liquor more on one ſide than another; but as the Blood can't re-enter into the Heart, it is determined to flow thro' the capillary Extremities. This being ſtated, let us ſuppoſe that a thick Matter ſtops the arterial Extremities. *1ſt*, As the Motion of the Blood will be very ſlow in theſe Extremities, we ſhall there perceive Cold. *2dly*, The arterial Veſſels will ſwell, and we ſhall perceive the Arteries to beat that did not beat before. *3dly*, The more extended Arteries will act againſt the Heart, which by that will be obliged to beat oftner, ſince the Vibrations of the Fibres will become ſtronger. *4thly*, The Obſtructions may give a more frequent Pulſe again in another manner; for let us ſuppoſe that the Heart has ſix degrees of Motion, and that it can't be emptied entirely becauſe of the Obſtruction of the Arteries, then the Vibrations not being ſo large, will neceſſarily become more frequent; and it is this we may remark in Palpitations. It follows from all this, *1ſt*, That the Plethora muſt augment the Number of the Pulſations of the Heart; for the Plethora produces the ſame effect as the Obſtruction, ſince the Blood cannot paſs freely in the one nor the other Caſe. 2*dly*, That if there is a conſiderable Inflammation, the Pulſe muſt be more frequent every where, for the Inflammation comes from nothing but the Obſtructions. 3*dly*, That the Arteries that are in the inflamed Part muſt beat ſtronger, ſince they are more filled. 4*thly*, That the Heat and Fatigue that gives Motion to the Blood and Vibrations to the ſolid Parts, muſt produce a more frequent Pulſe. 6*thly*, Almoſt all the other Differences that are found in the Pulſe, may be reduced to theſe; there are ſome in which *Bellini* ſhows a great deal of ridicule. 1*ſt*, The wavy Pulſe is that which when many Fingers are applied to the Artery, ſtrike the firſt ſtronger, the ſecond weaker, &c. *Bellini* had reaſon to ſay that the Fingers produced this Difference: the Blood that is ſtopped by the firſt Finger muſt ſtrike it ſtronger than the ſecond, &c. but it may happen that the Heart contracting ſlowly propels the Blood, if we may ſo ſay, in ſhowers. 2*dly*, The vermicular Pulſe is nothing but Imagination; for the Motion of Worms is made by one of their Parts that ſwell, whilſt the other which becomes leſs is propelled forward; if there is any thing like it in the Vibrations of the Arteries, this proceeds from nothing but the Fingers that we place thereon. 3*dly*, The Pulſes that we named *Formicans*, *Caprizans*, *Myurus*, *Dicrotus*, *inæqualiter inæqualis*, *impar citatus ſerratus*, merit not that we ſhould ſtop here; if thoſe that contrived all theſe Names, had underſtood Geometry, they had ſpared themſelves the pains of ſeeking all theſe Differences which by no means we can obſerve.

7*thly*, The intermittent Pulſe is that which having beat twice in a certain Space of Time, beats more or leſs during the ſame time; that which produces it is nothing but a Cauſe that interrupts the Action of the Fibres of the Heart, let us ſee whether we can find it. *1ſt*, If there be a Preſſure on the Nerves in the Brain, and that that Preſſure were ſurmounted or finiſhed, in the time that it is neceſſary for the Heart to contract twice or three times, it is certain that then there would be an Intermiſſion in the Pulſe. *2dly*, It is certain that there is in the Nerves a Matter which gives them their Tenſion; but if it happened that this Tenſion ceaſed by the defect of that Matter during ſome Moments, another Intermiſſion would happen again in the Motions of the Heart. *3dly*, There may be formed Excreſcences at the Baſis of the Heart, the Fat often augments, there then ſometimes happen ſtony Concretions and Tumours; all theſe Cauſes may hinder for ſome time the entrance of the Blood into the coronary Arteries, and the Heart will interrupt its Motions till that Reſiſtance is ſurmounted. *4thly*, Theſe ſame Cauſes may compreſs the Artery, Aorta and Pulmonary; if theſe Reſiſtances are more conſiderable than the force of the Heart, the Pulſation will not be performed till that the Blood being propelled into the Ventricles in great quantity, the Heart by its reiterated Efforts ſurmounts an Obſtacle that ſtops the Blood; a Polypus, Stone and Tumour, that will happen in the Artery, will produce the ſame Effect. *5thly*, If that which oppoſes the Contraction of the Heart, can produce an intermittent Pulſe, that which will oppoſe its Dilatation will do it alſo. Let us ſuppoſe that there be a Tumour in the Pericardium, or that that Bag be filled too much with Water, or, in a word, that ſome other Cauſe whatever preſſes much the Heart; if that Preſſure ſurpaſſes the ordinary force with which the Heart dilates, there will happen an Intermiſſion in the Pulſe till that by many reiterated Jerks the Preſſure be ſurmounted. *6thly*, If it happened that the Blood did not run into the Ventricles, the Heart in re-eſtabliſhing, cannot dilate the Arteries, conſequently the Pulſe would not be perceivable till that hindrance were taken away; for this may happen thro' many Cauſes. *1ſt*, It may ſurmount a Tumour in the Cavity of the Auricles. *2dly*, Some excreſcence may there be formed. *3dly*, The ſame thing may happen to the Veins, be it to the Vena Cava, or to the Pulmonary Veins. *4thly*, If the Blood were wanting, we ſhould ſee the ſame Inconvenience happen; when one of theſe hindrances is met with, we muſt wait the Blood's being heaped in a great quantity; then as it has a great deal of Motion becauſe of the augmentation of its Maſs, it may force the Obſtacle that hinders it from flowing into the Heart. *7thly*, If any Matter is heaped in the Capacity of the Breaſt, and that it preſſed the Auricles and Veſſels, we ſee that then the Courſe of the Blood being interrupted, the Pulſe muſt be alſo, for this may be found in a Dropſy and Empyema. *8thly*, Let us ſuppoſe that there is a Body in the Arteries that hinders the Blood's flowing from the right or left Ventricle, the Pulſe will not beat, a Polypus and a Tumour can produce the ſame effect. *9thly*, Let us ſuppoſe that the Nerves of the Heart entered into Convulſions, the ſtraitning that would happen then to this Muſcle would hinder it from dilating as before, the Contraction would be ſtronger and longer, there would then be a longer Interval, during which the Pulſe would not be perceived; it is this that happens in great Pains; by this we may explain the Intermiſſion that happens to the Pulſe by the Violence of the Paſſions, by a ſtrong Smell, by the Diſorders that happen to the Ventricle, becauſe of the Nerves that communicate with thoſe of the Heart, by hyſteric Convulſions, by the Convulſions of the Nerves that tye the Jugulars and Carotid Arteries. 10*thly*, A large Evacuation may alſo produce an intermitting Pulſe, for the Veſſels going to have more force than the Heart, are *in equilibrio*; and thus the Heart can't propel the Blood there. *Bellini* pretends to explain how a bleeding may cauſe an intermittent Pulſe when the Blood begins to flow; the Orifice being made, ſays he, all the Blood is carried thither immediately, becauſe there it is that it finds leſs Reſiſtance; thus the Preſſure of the Brain will be much leſs; the animal Spirits will not there be formed as before; this defect of the Spirits will cauſe there being leſs force in the Heart; thus the Pulſe may become intermitting, this Explication can't be ſupported, we draw a very great quantity of Blood the moſt part of the time, without the Intermiſſion of the Pulſe. 11*thly*, A Plethora may produce an intermitting Pulſe; for if the Blood was in ſo great a quantity in the Heart or in the Artery that the Heart could not be emptied, or that the Artery gave not a Paſſage to the Blood that is propelled by the Heart, we ſee that there might be no Pulſation. 12*thly*, In a Man of an ill Conſtitution, the Pulſe may become intermitting by one of the Cauſes which we have been ſpeaking of; if he has too many Humours it is the Plethora; if he has but little Blood, this is the force of the Veſſels that will carry it over the Heart; if the Veſſels are dried, there will be Obſtructions that will ſtop the Blood, for on the Cauſe of its drineſs it cannot paſs from the Arteries into the Veins.

The Veins.

After having ſpoke of the Pulſe, we muſt talk of the Circulation of the Blood in the Veſſels. The Antients believed not that the Fluids that give life to our Body were immoveable; they there diſcovered ſome Progreſſion, but they never thought that the Blood going through the Arteries returned into the Veins, and then to the Heart. This does not at all appear in their Works. This Diſcovery belongs to late Times. It is generally affirmed that *Harvey* was the Author of it; it is true that he publiſhed it, but we can't diſagree but on the occaſion of the Valves, on the which *Aquapendente* made but general Obſervations. *Frapolo* concluded not that it was neceſſary that they ſerved for a Circulation of Fluids; it is then that great Genius that we muſt look on as the firſt Author that advanced that the Blood circulated from the Arteries to the Veins; beſides, it is certain that the *R. P. Fabri* printed a Theſis two Years before *Harvey* publiſhed this Diſcovery. This *French* Jeſuit there advances that the Blood circulates from the Arteries into the Veins to return to the Heart. Before we examine this Motion of Circulation that gives life to our Body, we will relate ſome curious Obſervations of *Leewenhoek* on the Progreſſion of the Blood in the Arteries; but we will firſt examine the Veins, ſo that we may more clearly explain Circulation.

The Figure and Diſtribution of the Veins anſwer almoſt to the Figure and Diſtribution of the Arteries; there are three Coats in the Veins, one Membranous, one Vaſcular, and one Muſcular; but theſe Coats are thinner than thoſe of the Arteries. Theſe are the other Differences that happen between theſe two ſorts of Veſſels. 1*ſt*, The Capacity is larger in the Veins, it may be alſo that the Ramifications are more numerous. 2*dly*, There are in the Veins Valves, ſome are ſolitary, and have the form of a Thimble at the Inſertion of the ſmall Trunk into the large ones; the others are double, and ſituated in oppoſite Parts in the large right Trunks diſtant from the Heart, and where the Blood mounts perpendicularly; theſe Valves are called *Sigmoides* or *Semi-lunares*; they are ſo diſpoſed as not to permit the Blood to return on its way. *Bergerus* pretends that they act as ſo many little Muſcles which by their Contraction propel the Blood; but this has no Foundation, there are none found in the Vena Porta, nor in the pulmonary Vein. 3*dly*, The Inſertion of the Vena Cava and Vena Pulmonalis in the venal Bags, is found fleſhy. 4*thly*, A little Tubercle is found between the Vena Cava aſcendens and deſcendens; it is according to *Bergerus*, that the Blood which riſes might not hinder that which deſcends from entering into the Auricle, but he proves not what he advances. 5*thly*, Not only the venal Veſſels run ſtrait, but they fix to the ſides of the Ramification in ſuch a manner as the Anterior communicate with the Poſterior, the left with thoſe that are at the right; theſe Inoſculations form a ſort of Network like that formed by the Veſſels of the Leaves of Trees; this is particularly in the ſkin. 6*thly*, The Veins don't beat for the following Reaſons. 1*ſt*, The Arteries are Cones where the Blood propelled towards a Point find always more Reſiſtance, but in the Veins the Blood is propelled from the Point towards the Baſis; thus it there finds leſs Reſiſtance, and conſequently forces not the Sides of the Veins ſo much. 2*dly*, As the Blood paſſes not into the venal Extremities but by degrees, in ſuch a manner that we often find but one Globule paſs at once, we ſee that this can't cauſe any ſenſible Motion to the beginnings of the Veins; for if the Motion is not perceived in the beginning of the venal Veſſels where there is a little Matter, we ſhall not perceive it in the large Trunks where it is neceſſary to be divided. *3dly*, The Blood paſſes into leſſer Particles from the Arteries into the Veins, be it during the Contraction of the Heart, be it after; for the Arteries in contracting expel the Fluids they contain; thus we ſhall not perceive in the Veins an alternative Motion. *4thly*, There is but the origin of the Veins near the Heart in which we find alternative Motions, and belongs beſides this but to the Vena Càva, as we have obſerved; the Dilatation is cauſed by the Contraction of the Auricle that receives the Vein, we clearly ſee that the Auricle can't contract without that Vein ſwells by the Blood that it receives, it contracts at laſt by its Action. This is the Structure of the Veins, and their difference from the Arteries; let us make ſome Remarks on their Origin. We have ſaid ſomething already in ſpeaking of the arterial Extremities, but this ſuffices not; let us examine the Reaſons of thoſe that have maintained the Continuation, and of thoſe that have denied it.

The Interruption of the Veſſels.

Theſe are the Reaſons which were made uſe of to eſtabliſh the Interruption of the Veſſels. *1ſt*, When we make an Injection in any of the Parts in the crural Artery for example, the Fluid returns not through the Vein, till after the Parts were much inflated, this ſhows that the Fluids from the Arteries enter immediately into the Poroſities of the Parts, and that they are not inſinuated in the Veins but when they find no more Space than they can occupy; they anſwer to this, that Injections were often made that paſſed immediately in the Veins, without any Tumour happening in the Part; but we muſt grant that the contrary happens in many Injections. 2*dly*, They ſaid that Water injected in a Muſcle would give it Motion, and that the Fibres became white; but let us ſuppoſe that all the Veſſels be Lymphatic, Sanguinary, and have no Interruption, the ſame Thing would happen. Thus this Experiment proves nothing againſt thoſe that maintain the Continuation of the Veſſels. 3*dly*, It was objected that the Nouriſhment of the Parts could not be made, if the Veſſels were continued. But 1*ſt*, We muſt prove that the Matter that nouriſhes the Body can't eſcape by the Poroſities of the arterial Extremities. 2*dly*, That the Nouriſhment is not ſimply performed by the ſwelling of the Veſſels, for we have not yet proved that theſe two Things can't be performed. 4*thly*, *Lower* has ſhown us that if we tye the jugular Veins of the Vena Cava of a Dog, the Animal becomes immediately dropſical; it is neceſſary then that the Veſſels be interrupted, for otherwiſe the Lymph can't expand from the Veſſels; it is certain that ſome little of the Lymph can go through the Pores; but we muſt own alſo that it appears difficult that a Quantity large as that, extravaſates without there being any Interruption. Thus this Experiment proves better than thoſe we have been ſpeaking of, the Interruption of the Veſſels. 5*thly*, It is without Reaſon that *Bohn* advanced to prove the Interruption, that the Fluids never enter in very ſmall Ducts while they find larger. 1*ſt*, If the Parts of the Liquor have a Diameter ſmaller than thoſe ſmall Ducts, they will be introduced if they are compreſſed. 2*dly*, We have nothing to bring for an Example but the ſecretion of the Chyle, and the entrance of the Blood into the coronary Veſſels; in a word, we muſt be ignorant of the firſt Ideas of the Hydraulic Mechaniſm to make this Objection. *6thly*, There were many other Reaſons brought to prove it was neceſſary that there ſhould be an Interruption between the arterial and venal Veſſels; I'll ſay nothing of them becauſe they are of no Validity: I will give the Reaſon of thoſe that maintained that the Veſſels are not interrupted.

1ſt, The Eyes prove, ſays *Bergerus*, that in the Lungs, in the Uterus after Childbed, in the Coroide Plexus, the Arteries form a Network with the Veins; and it is very likely hence that the Veins are a continuation of Arteries; we can't prove by the Teſtimony of the Senſes that there is an Interval that is not vaſcular between the Arteries and Veins; *Swammerdam*, on the report of *Craanen*, could diſcover nothing in all his Experiments but Arteries and Veins. *2dly*, We ſee plainly, ſays the ſame Author, this continuity in the Veſſels of the Kidneys, if we inject a Liquor thro' the venal Artery, it returns by the Vein, and when we fill them with ſome Matter, we ſee no Interruption; but neither do we ſee clearly the continuation. *3dly*, In the ſpermatic Veſſels, adds the ſame Author, the Eyes can't diſtinguiſh the Arteries from the Veins at their junction; if we tye the ſpermatic Vein near the Vena Cava, and the Baſis of the pyramidal Body, the Liquors we inject thro' an Artery returns by the Vein in an inſtant, and ſwells it; but *Bergerus* has given no attention to the Communication of the pyramidal Bodies with the neighbouring Veſſels; it is by this Communication that the ſpermatic Vein ſwells. *4thly*, The continuity of the Veins and Arteries is proved again by the Bones, ſays *Bergerus*,

gerus, ſince we ſee that the Arteries which enter by an Extremity and are carried towards another, continue with the venal Ducts, and that there are found numerous Ramifications of one or the other of theſe Veſſels that interlace and return to the Membrane that covers the Cavity of the Bones. But I know not whence this Author concludes we ſee a true continuation; we can't demonſtrate it; from all this it follows, that in Man there is no certain Proof which demonſtrates that the Arteries are continued with the Veins. 1*ſt*, As we have ſaid already, there are Parts where the Veſſels are really interrupted. 2*dly*, In all the Injections that we can make in other Parts, the Part between thoſe Veins and Arteries become ſo confuſed, that we can't ſay there is a true continuation; we muſt nevertheleſs own that we there remark no effuſion, as at the Spleen to the Sinus's that are at the ſide of the Saddle and in the cavernous Bodies; but there is no doubt that the venal and arterial Veſſels don't continue in the Bladders of Frogs. *Malpighi* has obſerved, that when they are filled with Urine we there ſee the Blood circulate thro' diaphanous Veſſels that join, the ſame as the Fibres of the Leaves of Trees. Theſe Inoſculations, adds *Malpighi*, are not extraordinary: There are found in the Inteſtines and other Parts, that the vaſcular Extremities are confounded in forming Networks: *Leewenhoek* has again demonſtrated more clearly the continuation of the arterial and venal Veſſels; in Frogs, Eels, Turbots, and other different Fiſh, he has diſcovered thro' a Microſcope that the Blood paſſed from the Arteries into the Veins, without there being any interruption in the Veſſels; the Veins appear but as filled Arteries that take their way from the Heart; he has even obſerved three arterial Ramifications that bended

obliquely,

obliquely, and went to reunite in a larger venal Trunk that they forced by their concourſe; it is above all in Frogs that we eaſily obſerve the circulation of the Blood; I ſhall ſpeak of it in another Place.

From all theſe Obſervations made in Animals, many Philoſophers concluded that the Arteries in Man were continued with the Veins; *Pitcairn* eſpecially would prove that the Circulation permitted not that there ſhould be interruption. *1ſt*, He pretends that if the Blood expanded in leſs Spaces between the Vein and Artery the Blood would not circulate; but I don't ſee wherefore: what will happen is, that the Blood coming from a narrow Space to a larger, its Motion will abate; neverthele'ſs by the force of the Fibres which environ theſe Spaces, and by the Pulſion of the Blood flowing thro' the Artery, the Blood there would be propelled into the Vein, and would be even pumped; for the Cavity of the beginning of the Vein being empty, the Fluids which would meet at its Orifice would there conſequently enter with force, by the ſame reaſon that the Sucker is propelled into the Air-Pump. If it be aſked, why the viſcous Extremities empty? it is, becauſe the Blood is propelled by the neighbouring Arteries; and as the Orifices of the growing Veins are very ſmall, the Sides don't approach eaſily; thus it muſt there have an empty Space.

2dly, *Pitcairn* pretends that if the Parts between the Veins and Arteries widened, the Blood could not freely circulate; but he doth not prove this ſolidly: I own, that if there happened a Diſtenſion in thoſe Places againſt Nature which were conſiderable, a ſtrangling might happen in this Place; but provided that the Sinus's were very elaſtic, and that it were not formed by a violent

Extenſion, the Blood will circulate perfectly; to prove this, we have nothing to do but to take for example one of the Cellules of the Spleen; nevertheleſs the cellular Spaces are Spaces of Bags that ſhould, according to *Pitcairn*, ſtrangle the Orifices of the Veins; but the Reaſonings prove nothing againſt the Experiment. We have juſt ſeen the arterial and venal Veſſels that contain the Blood, let us look into the Veſſels where the circulation of the Lymph is performed.

1*ſt*, As there are Veins and Arteries to contain the Blood, there are alſo Veins and lymphatic Arteries. This is demonſtrated, 1*ſt*, By the Eyes; it is certain that the Humours of the Eyes are contained in Veſſels that come from the Arteries, for the Injections paſs there. 2*dly*, Theſe Veſſels tranſmit the Lymph they contain to the Veins. 3*dly*, The Fleſh owes its whiteneſs to the Veſſels filled with Lymph that creep between the Skin and Epidermis; theſe Veſſels return to the Veins, ſince it is neceſſary that the Humour they contain be carried there.

2*dly*, There is another ſort of lymphatic Veſſels of which we have already ſpoke; they are every where interrupted by Valves, and differ from the preceding, 1*ſt*, By their Knots that are formed by the Sigmoide Valves. 2*dly*, That the Blood never paſſes in thoſe; whereas if it often paſſes in thoſe of which we have been ſpeaking, we may prove that the Blood paſſes in thoſe Veſſels, 1*ſt*, By the Inflammation of the Eyes, for there happens nothing elſe if it is but the Veſſels that generally receive an aqueous Humour, receive then Blood. 2*dly*, By the redneſs that appears in the Face and other Parts of the Body, when we rub them or when we are in action; we muſt not imagine that the Blood only paſſes in a larger quantity in the Arteries, it is evident that it makes a Paſſage in the lymphatic Veſſels which go from the Arteries, and which are too ſmall to permit it to paſs when it is not propelled violently; the *Moors* have their black Colour from nothing but becauſe theſe lymphatic Veſſels that in us are filled with Lymphs, in them are filled with Blood.

The Lymphatic Veſſels.

3dly, The lymphatic Veſſels are compoſed, as we have already ſaid, of a very fine and tranſparent Membrane, that forms a Cavity interrupted by very numerous Valves to hinder the reflux of the Lymph. *3dly*, There were many Opinions on their origin; many believed that they came from the Fibres or their Interſtices, others advanced they came from Arteries. *1ſt*, If we make any Injection in the Arteries, it paſſes in the Veins and lymphatic Veſſels. *2dly*, When we blow into the Arteries, the Air ſwells the lymphatic Veſſels. *Borichius* ſays that having blown into the cæliac Artery, the thoracic Duct ſwelled immediately. *Bartholin* tried the ſame Experiment; it is needleſs to mention other Authorities, there has no Body laboured at Anatomy but who has ſeen this: Lukewarm Water eſpecially has an eaſy Paſſage in the lymphatic Veſſels; there is an Author who ſays, that having blown in a renal Vein, he ſaw the lymphatic Veſſels ſwell; this might prove that they did not come from Arteries. *2dly*, The Blood that comes through the Arteries has twice the Seroſity of that which comes through the Veins; it is neceſſary then, according to ſome Authors, that the lymphatic Veſſels come from the Arteries and not the Veins; at leaſt, according to their Idea, we may hence prove that the Seroſity can't come from any Part but the Heart; beſides, be it that we take that which is in the Arteries, Veins, common Receptacle, or in the Lymphatics, it always is found the ſame; when we expoſe it to a ſlow warmth the aqueous Part exhales; there are little Balls formed, and a gelatinous Matter in its texture like Honey-combs at the bottom of the Veſſel; it differs only that the holes of the Comb have ſix ſides, whereas thoſe of that gelatinous Maſs are cylindric, they are the Globules that are raiſed during the Evaporation that have formed them, but the Seroſity contained in a larger quantity in the Arteries than in the Veins, proves only that the lymphatic Veſſels come not from the Veins; but we can't prove hence that they go from the Arteries, they may take their riſe in that ſeparation. This alſo does not prove that the Lymph can't come at leaſt in Part from any where but from the Heart; it might be that the Lymph were the ſame in all the arterial, veinous and lymphatic Receptacles, although they came from the Nerves and other Places.

4thly, There are Authors who pretend that the Lymphatics were nothing but Veins that inoſculate with the Nerves, but they bring no ſolid Proof that theſe Veſſels receive that which goes from the Arteries; thus they are Veins in compariſon to the Arteries; all that we can ſay is, that the Juice which is the Nerves muſt return in part through theſe Veſſels; I ſay in part, for it muſt paſs equally through the ſanguinary Veins. But what Proof have we to ſhow this Circulation? The Nerves, ſay they, contain a Juice that muſt circulate as the Blood and the Lymph; this would be true, if we ſhewed that the nervous Juice evaporated not, perhaps that this Juice cauſes nothing but tranſudation, and that it inſinuates thus in the ſanguinary and lymphatic Veſſels: I mention not the Opinion of *Bilſius*, we know not upon what he ſupported that which he advanced on this Head.

5thly, To determine the Origin of the lymphatic Veſſels we muſt know the Origin of the Veins; they may go out as they do from ſome pulpous Cellules: We have in another Place ſaid, that in blowing into the Veins, it happens ſometimes that we ſwell the Lymphatics; this proves that they come from between the Veins and Arteries.

6thly, After having ſpoke of the Origin of the lymphatic Veſſels, we muſt come to their Subſtance: We ſaid, that they were compoſed of a Tunic very thin and tranſparent; we muſt add, that the thicker they are and approach the thoracic Canal, the Subclavian or Axillary, the ſtronger their Membranes are; this Membrane, which appears thin and tranſparent, offers nothing extraordinary to the Eyes, but when we examine them through the Microſcope, we there find a wonderful ſtructure; it is compoſed of ſmall Globules joined the one to the other, theſe Globules thus joined make the Lines by their Interſections form Areas as Lines that croſs one another on the ſkin of the Hand, the Membrane which compoſes the thoracic Canal has the ſame ſtructure, it differs not but in that theſe Globules are larger, and that in many Places they are more preſſed, that they form a ſort of a Bunch of Grapes, and appear more diſtinctly; we may there diſtinguiſh two Laminæ, the external appears compoſed of round or oval Corpuſcles that are larger than thoſe of the Internal which differ from the External in nothing elſe; the ſtructure of the lacteal Veſſels are the ſame.

7thly, The lymphatic Veſſels are divided by ſemilunar Valves; they are found in the Veins ſometimes

times to the Number of three or four together, but here they ſucceed not the Number of two; this multiplication of Valves alſo appears not to be neceſſary in the Canals of the Lymph; they are very ſtrait, and hence they can be ſhut by two ſemilunar Valves at every Knot; theſe Valves appear to have the ſame ſtructure as the Membranes of the Veſſels; but when we have examined them thro' the Microſcope, we diſcover in the Membrane which compoſes them, Fibres that appear deſtined for the contraction and relaxation of the Valves; we obſerve ſmall orbicular Corpuſcles fixed on one ſide and the other to theſe Fibres; in the Valves of the thoracic Canal, between the Fibres of which we have been ſpeaking, we find other at the ends; they croſs diverſly, and are perhaps as ſo many ſmall Muſcles.

8*thly*, Theſe Veſſels after having paſſed ſome Way, enter into the glandular Bodies, the ſtructure of which is as follows: 1*ſt*, We find a ſtrong Membrane that inveſts the Gland, and has Veſſels that enter there and others that go from it. 2*dly*, Under this Membrane there is another ſtronger compoſed of fleſhy Fibres, which from the Circumference bear themſelves at laſt in the interior Part of the Gland. 3*dly*, Theſe Fibres entring into the Gland, croſs diverſly, and form many Areas by their Interſections. 4*thly*, In theſe Areas are contained Follicles, ſometimes they are in Number two, ſometimes three. 5*thly*, Theſe Follicles are formed by a Membrane, round which we ſee ſometimes Networks of ſanguinary Veſſels. 6*thly*, The Follicles are hung on the ſanguinary Veſſels that break by the Fibres that form the Areas; theſe Veſſels being filled with Wax or other Matter by Injections, pull down the Follicles, and make them diſappear; thus if they appear filled in all the extent of the Glands, we can't conclude that the Glands are nothing but bottoms of Veſſels; theſe Arteries are conic, crooked, elaſtic, and form divers Circumvolutions, divide in different Ramifications, but their Extremities have no Ramifications, they are cylindric, and changed then into Veins; before this change they communicate by an infinity of Inoſculations, form divers Angles, take Poſitions that vary very much; the Veins that anſwer to theſe Arteries have the ſame Courſe, and appear in the ſame diſtribution. *7thly*, The Nerves throw the Ramifications, in proportion, more numerous in the Glands than in other Places, but we muſt take care not to take for Nerves the Filaments, which are nothing but a fixing of Fibres that form the Areas. *8thly*, In theſe Glands enter the lymphatic Veſſels which ramify at their entry, and divide themſelves thro' all the Gland, ſo that the Injections extend through all the Subſtance, and goes out of the oppoſite Veſſels that come from the Gland by Ramifications, and anſwer in all to that which there enters; we are not come yet to diſcover the Extremities of theſe Veſſels in the Glands; there is an appearance that they are not continued, and that the *Vaſa deferentia* propel their Fluid into the Cellules of the Glands, and that thoſe that go out from it repump it. *9thly*, *Malpighi* aſks whether there is not a ſmall Follicle joined to the Extremity of each lymphatic Veſſel at its Origin: In the Womb of the Calf, ſays he, we ſee ſmall Sacks fixed to the Extremities of the Veſſels, there drops a glutinous Humour in theſe Bags; we obſerve after certain Maladies that the Liver, Spleen, and other Viſcera, are filled with ſmall Grains; this might make us ſuſpect that theſe little Bags are at the Root of the Veſſels. But we can conclude nothing from an unnatural State, the Maladies diſorder the natural texture of the Parts. 10*thly*, The Colour varies in the ſubſtance of the Glands; it is aſh-coloured, red, brown, yellowiſh, the ſolidity is not always the ſame; we find ſome have a lax texture, others have a very firm ſubſtance; this depends on the greatneſs of the Areas.

11*thly*, The uſe of theſe Glands is very uncertain; it was ſaid that they ſerved to ſhut up the Diviſions of the Veſſels, to imbibe as Spunges the ſuperfluous Humours, to moiſten the Parts, to give the Nerves and nouriſhing Juice to furniſh the Fat. All this is but imaginary. *Malpighi* ſeeing their muſcular Structure, looked on them as upon ſo many little Hearts that gave the Lymph its progreſſive Motion. This ſeems at firſt ſight neareſt to truth. But when we conſider that the texture of theſe Glands is very commonly ſtraitened, that the Veſſels that enter there divide into an infinity of Ramifications, that thus the entry of theſe Glands become very ſtrait, that the Arteries which are there inſinuated oppoſe by their Pulſation the entry of the Fluids, ſhould we not be tempted to ſay that this Uſe has no more foundation than the others? 12*thly*, The uſe of the lymphatic Veſſels is not leſs uncertain; there have been ſome Authors that advanced they were deſtined to refreſh the Parts; but would they not be equally refreſhed if the Lymph came through the Veins? As for thoſe who ſaid that theſe Veſſels ſerved to carry back the Lymph that remains after Nutrition, what did they pretend to? Is it that this ſame ſuperfluous Lymph could not return thro' the ſame Veins? 13*thly*, We cannot determine the uſe of the Parts but by the Phænomena they preſent; in the lymphatic Veſſels we ſee nothing elſe but 1*ſt*, That they carry the Lymph into the receptacles of the Chyle. 2*dly*, That this Lymph is neceſſarily divided in paſſing thro' the Glands; if we were aſſured that the Lymph nouriſhed the Parts, that for this reaſon the Lymph left the common Courſes of the Blood, we might believe that what were there ſuperfluous would return thro' theſe Veſſels, altho' Nature might have found a ſhorter Paſſage in inſerting them immediately into the Veins. As for the Glands, we may ſay 1*ſt*, That as the Ramifications of the lymphatic Veſſels are very long, there needed ſome tye to faſten them. 2*dly*, That the Lymph which eaſily coagulates by the Heat, is eaſily kept more fluid in paſſing thro' the lymphatic Veſſels that are very ſtrait, and interrupted by an infinity of Valves divided into ſeveral Ramifications in entring into the Glands. 3*dly*, That the Glands perhaps furniſh a new Matter ſeparated from the Arteries that are there confined. 4*thly*, That the Nerves throw perhaps their Juice into the Cellules of the Glands. The Lymph is the Spring of many Maladies; it is not difficult to comprehend that as ſoon as there happens ſome weakneſs in the Glands, or that they will be obſtructed, there will happen great diſorders. The Gout is truly a lymphatic Malady, the ſynovial Glands are attacked, they are diſtended, and forced by the Lymph that is thrown there in great quantity, and thickens at laſt ſo as to form a plaſtic Matter that comes very often out of the Articulations, and which we find in the capſulary Ligaments when we open the Joints of Bodies that were ſubject to the Gout. The Inflammation of the Eyes give an Idea of this ſickneſs; that the Blood ſtops in the Veins that carry back the Blood from the Eyes, that which comes after will preſs the Arteries, will augment their Diameter, will be inſinuated in the lymphatic Veſſels that receive the Humours, and this is the Inflammation, which is nothing elſe but the entry of the Blood into the lymphatic Veſſels, which being too narrow to receive them diſtend, and give a great deal of Pain; that the Blood be ſtopped in the Veins that expand in the Articulations and Glands; the arterial Blood, which ſent nothing but a ſoft Humour to moiſten the Joints, will there ſend a thicker Matter that will force the Veſſels of the Synovia and Glands; hence will follow all the ſymptoms of the Gout: It is not neceſſary to ſpeak of Particulars.

The Dropſy is nothing but an effuſion of the Lymph in ſome natural or unnatural Cavity; it will be formed 1*ſt*, If the lymphatic Veſſels come to break. 2*dly*, If the Lymph can't enter into the lymphatic Veſſels after its having ſeparated from the Blood; it is in this manner that a Dropſy is formed, between the Duplicature of the Membranes of the Peritonæum, and in all the Places where the cellular ſubſtance of *Ruyſch* is found, the Lymph is expanded in this ſubſtance as in a Marſh; if there happen there a Relaxation, it can be no more pumped by the lymphatic Veſſels, or by the abſorbent Veſſels that border on the Veins, it muſt therefore be heaped in the Cellules of that ſubſtance: as the Heat coagulates the Lymph, we can find in hydropic Perſons plaſtic Concretions, as *Foreſtus* takes notice in his Obſervations.

The Circulation of the Blood.

Before we explain the Cauſe of the Circulation, I will ſet down ſome curious Obſervations made on this Subject by two celebrated Authors, 1*ſt*, in the Tail of a Bull-head; *Leewenhoek* diſcovered by the Miſcroſcope more than fifty Places where the Blood came from external Parts towards the internal. 2*dly*, Afterwards he ſaw that the Veſſels which carried the Blood turned, and carried it towards the Heart; thus we need not doubt arterial Veſſels continued with the venal. 3*dly*, In theſe Places where the Arteries appear to curve, they were ſo narrow that they could not give Paſſage but to one globule of Blood. 4*thly*, Sometimes the globular Parts of the Blood became oblong. 5*thly*, The Parts of the Blood are ſo ſmall that a hundred thouſand equal not one grain of Sand of a larger ſize. 6*thly*, In the Frog the arterial Blood which enters in a Ramification of ſome Artery, returns ſometimes in its Way; this comes from ſome hindrance that oppoſes the Paſſage of the Blood in that Ramification. 7*thly*, *Leewenhoek* ſaw in Fiſh alſo the Circulation very rapid in venal and arterial Veſſels, whoſe capillary Extremities gave Paſſage to nothing but one only globule of Blood; but he could not purſue the ſmall Arteries to their Extremities. 8*thly*, After the Blood was propelled with force in an Artery at its Extremity, we ſee ſometimes that it flows back, and that at laſt it purſues its Way thro' another Place, but it appears to be formed a Veſſel. 9*thly*, In the Eel we plainly ſee the Circulation of the Blood; and *Leewenhoek* ſays in his Obſervations, that he has obſerved that arterial Extremities, thro' which there could paſs but two or three Globules of Blood, curve and became Veins. 10*thly*, In other Animals *Leewenhoek* obſerved alſo the Circulation; he has ſometimes ſeen a Clod of Blood that ſtopped an Artery whilſt the Blood paſſed thro' the Diameter of that Clod which was open; theſe are *Leewenhoek*'s Obſervations: The following are *Baglivi*'s, which are not leſs curious. 1*ſt*, When we examine the Blood in the Frog by the means of a Microſcope, we ſee that it goes into the Veſſels thro' Right Lines; theſe Lines have more ſwiftneſs at the Centre of the Veſſel than at its Circumference; when the Frog is a dying the progreſſive Motion of theſe Lines ceaſes by degrees, and the Blood reflects towards the Sides. 2*dly*, *Baglivi* obſerved that the Blood returns in the Veins; the Blood, ſays he, which ought to be carried through a Vein towards ſome ſuperior Part, deſcended thro' that ſame Veſſel, and was diſcharged in the nigheſt Trunk: to be convinced of the Exiſtence of this Motion, which appears contrary to the Laws of Circulation and the Poſition of the Valves, *Baglivi* rubbed one of the Veins of the Meſentery with Oil of Vitriol, immediately the progreſſive Motion of the Blood was ſuppreſſed in that Veſſel, and there was formed a Reflux as that which we ſhall now mention. 3*dly*, When the Frog dies, the Motion of the Blood decreaſes by degrees; but if then there happen Convulſions, the Circulation is re-eſtabliſhed immediately, and laſts as long as the Convulſions: As ſoon as the vital Motions ceaſe, the Blood paſſes entirely from the Arteries into the Veins; if there remains any thing of it there, they are ſome adipoſe Globules which are more numerous, when the Frog dies ſome time after it was taken; if we preſerve it a long while, we ſee but little of it, eſpecially if it eat nothing. 4*thly*, If we put the Heart of a Frog on a Table expoſed to the heat of the Sun, it will beat half an hour, altho' ſeparated from all the Viſcera; if we cut it in pieces, the alternative Motions of the Syſtole and Diaſtole will there equally appear; and when they come to ceaſe, we have nothing to do but to prick theſe bits of the Heart with a Pin, and the Motion will appear again. *5thly*, If we tear out a Frog's Heart, it will jump, move the Head and Eyes, will have Convulſions, and will ſwim; all theſe Motions will ſubſiſt ſometimes an Hour after the Heart is taken away; but when we take away its Brain, or cut off its Head, it dies immediately; the contrary happens in very hot Animals; the Heart palpitates a long time in a Cock; as, for example, after its having its Brain taken out. Theſe are the principal Phænomena that the Circulation of the Blood in Animals preſents; let us ſee before we explain it the Action of the Heart that gives Motion to our Fluids. The following are a few Obſervations which are neceſſary to comprehend the Circulation.

The Ventricles of the Heart are nothing but two muſcular Bags which can contain almoſt an Ounce of Blood; the Auricles alſo are two muſcular Bags that ought to be looked upon as the Antagoniſts of the Ventricles; for we ſee the Ventricles and Auricles contracting and relaxing alternatively, when we inject Water thro' the Veins, in Animals that have no more Life. The right Ventricle is a little larger than the left in Adults, the right Auricle alſo is more capacious than the pulmonary Bags, but in the Fœtus the right Ventricle is twice as large; hence it is that the pulmonary Artery is larger: It follows from this Obſervation, that if the Ventricles were compoſed of an equal Number of Fibres equally ſtrong, the left Ventricle would have more Force in regard of the fluid Matter, which will enter there, ſince it will be in a leſs Quantity.

As the fleſhy Pillars of the Heart are a continuation of muſcular Fibres that compoſe the Ventricles, they ought to have the ſame Action.

The Contraction of the Heart, *i. e.* the ſtraitning of its Cavities, is performed, 1*ſt*, By the ſhortning of the tranſverſal Fibres. 2*dly*, Thro' the Contraction of the longitudinal Fibres, we may aſk, What Fibres have moſt Force? This may be eaſily determined, if we obſerve that the tranſverſal Fibres are more numerous than thoſe that go from the Point to the Baſis; thus they will act more ſtrongly: the longitudinal Fibres do nothing therefore but counterbalance their Action, perhaps they will not ſhorten becauſe of the Force of their Antagoniſts; we ſee by this that the Heart ſhould be elongated during the Contraction.

There is a great deal of difference between the Force of the right Ventricle and that of the left; the right Ventricle is more lax, and has leſs numerous Fibres; the Reaſon of which is, that it is neceſſary that the right Ventricle only propel the Blood in the Lungs, whilſt the other ſends it thro' all the Extent of the Body; it is not therefore neceſſary that the right Ventricle ſhould be as ſtrong, becauſe of the Space that the Blood which it propels muſt run over; beſides, the Air going to inflate the pulmonary Veſicles, the Blood might enter into the Lungs without a great deal of difficulty.

When the Motion of the Heart has ceaſed in an Animal, and we raiſe it again by blowing or otherwiſe, the Auricles begin immediately their Pulſations, and at laſt come the Motions of the Heart, by which the Body becomes immediately harder, and its Point is carried forward in ſuch a manner that the Arteries ſwell ſometimes by the Blood which is there ſent.

If Animals are at the Point of Death, the Motion of the Auricles ſubſiſts ſome time after the Pulſation of the Heart has ceaſed. This is obſerved, eſpecially in the right Auricle; and when the Motion ceaſes in this ſame Auricle, it ſubſiſts ſtill during ſome time in one or the other Trunk of the Vena Cava: We obſerve alſo, that when we tie this Vein, immediately the Motion ceaſes in the Auricle, and that it there returns as ſoon as the Ligature is taken away. From theſe Obſervations it follows, 1*ſt*, That the Force or Action of the Heart depends in ſome meaſure on the Blood. 2*dly*, That this Force of the Auricle is independent of that of the Heart, the ſame as the Force or Action of the Root of the Veins, ſince it ſubſiſts when it is deſtroyed in the Heart, and that it there begins before the Heart is put into Motion.

If we tie or cut off from a Dog on each ſide the Neck of the Nerves of the *Par Vagum*, the Motion languiſhes in the Heart, and the Animal dies at laſt, as *Willis* and *Lower* obſerved it; but others have obſerved that Death comes immediately after. This ſhews, 1*ſt*, That the Motion of the Heart proceeds from the Nerves. 2*dly*, That the Heart has other Nerves beſides thoſe of the *Par Vagum* to cauſe its Motions, ſince its Action remains ſometimes after the Action is extinguiſhed in the *Par Vagum*; theſe Nerves come from the Intercoſtal.

Theſe are the principal Phænomena, which we find in the Action of the Heart; we muſt now prove that the Blood circulates, *i. e.* that from the Heart it is carried continually to all the Parts of the Body, and that it returns thro' the Veins; many Obſervations of which we have already taken notice, are a Proof of the Circulation; but we muſt give an account of the other Reaſons which demonſtrate it.

If we open an Artery, all the Blood flows out; it is neceſſary then that the Blood which was in the other Veſſels paſs into that open Artery; this can't be performed if it returned not to the Heart thro' the Veins; the Blood *v. g.* which is in the inferior Veins, can't re-enter into the Heart by the Arteries; the Valves oppoſe it at its return; it is neceſſary therefore that it return through theſe Veins when it is obliged to re-enter there; at laſt from the Heart there enters all in the ſubclavian Artery, if the Flux is formed by an Artery of the Arm; and it is this that we cannot conceive without a Circulation; for the ſame Cauſe that makes the Blood flow by an open Artery, makes it return by the Veins in the Heart: If we would have the Blood be emptied with Force, we have nothing to do but tie the Arteries which are not open, and divide the Blood; this proves ſtill the Circulation.

When we tie an Artery, it ſwells between the Heart and the Ligature, its beating becomes a great deal ſtronger, the ſame as in the neighbouring Veſſels; the Blood flows out of it with Force, if we make an opening there: on the contrary, the Part of the Artery that is between the Extremities and the Ligature is emptied, becomes lax, gives almoſt no Blood when we open it: That this Experiment may not fail, we muſt chuſe a ſolitary Artery; for if it is inoſculated with ſome large neighbouring Artery above the Ligature, we ſhould not find in the Experiment all the Phænomena mentioned; hence it evidently follows, that the Blood is continually propelled towards the Extremities of the Arteries in all the Parts of the Body, and that it returns not from the Veins into the Arteries, nor from the arterial Extremities

tremities in the neighbouring Parts of the Heart.

On the contrary, if we tie a Vein, the Part which is between the Extremities and the Ligature ſwells; and if we go to open it, the Blood which is in the Body is emptied by that, if it is not ſtopped by Swoonings; but the Part which is between the Ligature and the Heart fills, becomes lax, gives no more Blood when we open it; hence it follows evidently, that the Blood comes from the venal Extremities in its large Trunks to return to the Heart; there is but the Vena Porta, which will not ſwell between the Ligature and the capillary Extremities; the Blood is carried by this Vein into the Liver, and it there runs from a large Bed into a narrow one; it ſeems hence, that it ſhould be ſubject to beatings as the Arteries: But how could it beat, while the Veſſels whoſe Blood it receives, beat not? The Blood is there propelled by a Motion always uniform; thus there will in no place appear either their Syſtole or Diaſtole.

The right Auricle the ſame as the left, is a muſcular Bag compoſed of two rows of ſtrong Fibres, that have a contrary Direction; on one ſide it is fixed to the Orifice of the Heart by a Tendon, on the other it adheres to the Vena Cava; hence we ſee, that the Blood which will come from that Vein, and which will fill that Bag, may be propelled by the Spring of the Fibres in the right Ventricle, nothing oppoſes its entry: the tricuſpidal Valves, that are drawn into the Cavity of the Heart by the Pillars to which they are fixed, permit the Blood a free Paſſage; we may be convinced of all this by the Orifice of live Animals, and by Injections: But when the Blood is entred in the right Ventricle, then its Fibres by their Spring, 1*ſt*, preſs out of their Subſtance the Blood contained in the Arteries and Veins that are there extended, and of which many open into the Cavity of the Heart. 2*dly*, The Blood that fills the right Ventricle, being propelled by the muſcular Partitions of that Ventricle, rubs againſt the tricuſpidal Valves; but as theſe Valves are fixed to the Sides of the Ventricle by Fibres, they cannot be raiſed but to a certain Point; thus not being able to yield any more, they'll ſtop the Blood; but the ſemi-lunar Valves which are at the entry of the pulmonary Artery, reſiſt not as thoſe of which we have been ſpeaking: on the contrary, as they are like to Pigeon's Neſts, whoſe Convexity is towards the Cavity of the Ventricle, they yield to the Blood which comes from that Ventricle; it is neceſſary then, that as ſoon as the right Ventricle ſtraitens the Blood ſhould paſs into the pulmonary Artery; but when it will have entered in that Artery, it will not be able to return the ſame way; for the Neſts of Pigeons being ſwelled, will exactly ſhut the Orifice of the right Ventricle. All this which I have ſaid follows neceſſarily from the Structure of the Parts, and is confirmed by Injections made in living Animals and in Cadavera; all paſſes in the left Ventricle as well as in the right, the Blood is received in the venous Bag of the Lungs by four Orifices, which are found at its Angles; hence it is propelled in the left Ventricle: the mitral Valves which have the ſame Action as the tricuſpidal, permit it to enter; but when the Ventricle ſtraitens, they ſhut the Paſſage; then the Blood propelled againſt the three ſemilunar Valves placed at the Orifice of the Aorta, comes from the Heart to extend thro' the Body. This is the manner in which Circulation is performed: we muſt examine the Cauſe of the Motion of the Heart which is the Organ that propels the Blood in all the extent of the Body.

Opinions have been very various on the Subject of the Motion of the Heart, as this happens always in the Phænomena, of which Nature has not given us the Cauſe. The Antients and ſome Moderns believed that there was a concentered Fire which gave the Heart that continual Motion; at laſt *Deſcartes* gave us his Opinion, which differs not much from this; there is, ſays he, a ferment in the Heart which gives a great Expanſion to the Humours; as ſoon as one drop of Blood falls into the Heart it rarifies, raiſes the Partitions of the Heart by its Expanſion, and opens to the Blood that follows a Paſſage: The Ventricles thus filled, the Blood by its rarefaction launches into the Arteries, and then the Partitions of the Heart fall on themſelves. 1*ſt*, The Thermoſcope ſhews us not more heat in the Heart than in other Parts. 2*dly*, If we cut the Point of the Heart in a living Creature, the Blood which iſſues out with great Force, appears not to bubble. 3*dly*, By this Opinion the Blood ſhould go out during the Dilatation of the Heart, ſince it is the Rarefaction that propels it in the Arteries; nevertheleſs if we place our Finger in an Inciſion made on the Heart of a living Animal, we feel a great preſſure in the Contraction, and during the Dilatation we feel not this ſtraitning; it is by this Compreſſion that the Blood is propelled, as we ſee it, if we cut off the Point of the Heart, or an Artery near the Heart in a living Animal; for in the time that it happens the Blood guſhes out impetuouſly thro' its Orifices: That which led Mr. *Deſcartes* to ſay that it is during the Dilatation that the Blood is propelled out of the Heart, that is, the Pulſation of the Heart and Arteries is perceived in the ſame time; as he believed that the Heart could not beat but in filling, he is perſuaded that the Blood went not out but during the Expanſion of the Heart; for in that time the Blood could not iſſue by its Rarefaction, ſince the Partitions of the Heart, as we juſt have ſeen, are the only Cauſes that hinder it; the tenſion, hardneſs, paleneſs of the Fibres, which we obſerve during the Contraction, might have immediately confuted this Opinion; for againſt that which Nature teaches us, the Heart being forced by the Expanſion of the Blood, its Partitions ſhould be leſs extended, leſs empty, leſs white during the Contraction; we have nothing ſtill to conſider but the violence and hiſſing with which the Blood launches without interruption of the Arteries of thoſe which we unglue, we might ſee that there was neceſſary in the Heart a more conſiderable Force to propel the Blood: But without examining the Experiments that deſtroy *Deſcartes*'s Opinion, could we not by Reaſon only find Difficulties which it is impoſſible to anſwer? A drop of Blood that enters into the Heart, rarefies and opens the Ventricles to the Blood that follows: This Blood that follows, ought it not in the ſame manner to keep the Paſſage open to that which comes after? Hence it would be impoſſible that the Heart ever entered in Contraction. As for what regards the Cauſe of this Ferment, a mechanick Philoſopher would never make the great Creator intervene to form a Ferment which we cannot conceive nor allow of, according to the Principles of natural Philoſophy. To adjuſt this Opinion, ſome Philoſophers advanced that the Blood rarefying very much, the force of the Heart preſſed the Blood at its run, and made it run out till a new fermented drop gave it a larger Diameter; but the firſt Reaſons ſuffice to deſtroy this Opinion. This Opinion immediately was embraced, but ſome time after being rejected, other Cauſes were looked into for the Motion of the Heart; this is the explication of this Phænomenon, which preſently ſeem likely. 1*ſt*, All the Muſcles tend to Contraction; we ſee it by the Muſcles which we cut tranſverſly in living Animals, the cut Parts retire always towards their Inſertions. 2*dly*, Every Muſcle that has no Antagoniſt always contracts; for if it is cut, for example, the *Muſculi extenſores* of the Leg of a Dog, then the *Flexores* carry it, and keep the Leg always bent. 3*dly*, The Arteries are Muſcles, and propel the Blood by their Force into the Veins; if we tie the Aorta of a Dog at the Extremity of the Heart, all the Blood paſſes into the venous Veſſels; hence it comes alſo, that we find in dead Bodies the Blood in the Veins. 4*thly*, The Veins propel the Blood towards the Auricles of the Heart, 1*ſt*, By the preſſure of their Partitions. 2*dly*, By the preſſure of the Blood which ruſhes continually out of the Arteries; the Auricles by their Spring preſs the Blood that they contain; this Blood preſſed forces the reſiſtance of the Heart; in a word, the Heart by its re-action preſſes the Blood that it receives, and ſends it into the Arteries.

This manner of explaining the Circulation is all mechanical; behold the Blood that circulates by the Action of the Arteries on the Veins, from the Veins on the Auricles, from the Auricles to the Heart, from the Heart to the Arteries, we conceive that the Heart forced immediately by the Impetuoſity of the Blood that the Auricles ſend in its Ventricles, muſt be propelled farther than the Point where it would be *in equilibrio* with the Blood, by the ſame Reaſon that a bent Stick left to its Spring bends to the oppoſed ſide, inſtead of ſtaying at the Point where it is in a right Line, it muſt at laſt return on its Way by the force of its Spring; and this is the Reaſon why the Heart contracts.

There immediately appears nothing more reaſonable than this Hypotheſis; but let us ſay to a Mechanick, behold theſe elaſtic Ducts extended over the four Corners of a Chamber with a Heart of a great Spring in the middle; all theſe Ducts are thus diſpoſed, as perfectly to reſemble the Veſſels of the Body; what will follow when there is a Liquor injected there? May we propoſe to ourſelves of having found the perpetual Motion; certainly a Mechanick, altho' he be of no great Underſtanding, would boldly anſwer, that all theſe Forces would tend to the *Equilibrium*, and that conſequently the Motion would preſently ceaſe; this may be ſaid againſt this Opinion. Let us not ſay that Reſpiration and the Motion of the Parts take away always the *Equilibrium*; for Reſpiration and the Motion of the Parts, don't they owe their Origin to the Motion of the Heart? There was a Philoſopher who advanced, that it was the Soul that acted always in the Head which broke the *Equilibrium*; but this is to have recourſe to a Power we know not.

To find out the Cauſe of the Motion of the Heart, we muſt find a Force that acts alternatively. This Cauſe is in the Nerves, and this can be nothing but a Matter that vehemently runs thro' the ſmall nervous Ducts: To imagine that the Tenſion only of the Nerves ſuffices to explain the Motions of the animal Parts, is to have no Idea of the Conditions that require ſuch Motions; by the Tenſion only we ſhall never explain the Convulſions that happen to a Nerve that is pricked: Let us ſoftly prick the String of a Violin, it will make a few Vibrations; beſides, if all depends on the Tenſion, I don't ſee why when we tie a Nerve its Action ceaſes beyond its Ligature; we muſt therefore ſuppoſe in the Nerves a Principle acting againſt their Partitions and againſt their Extremities, the ſame as the Blood acts in the arterial Ducts; it is this intrinſick Force in the Nerves that gives Motion to all the Parts; but we muſt find a Cauſe that makes this Force in the Heart act alternatively.

Altho' it be from this Force which acts in the Nerves, it is certain that whenever we compreſs the Nerves, for example, that go to the Thigh, this Part becomes paralytick; if therefore we could find the Cauſe that made the Nerves of the Heart paralytic in the time that the Auricles act, we ſhould find in the Heart a Relaxation which would occaſion that the Blood might enter there: Let us ſee if we cannot diſcover this Cauſe; let us take the Heart in its natural State, *i. e.* in its Contraction.

The Matter that makes this Tenſion of the Nerves diſtending the Fibres of the Heart, it is neceſſary they ſhould preſs againſt each other, and ſhould ſtraiten the Heart; during this time the Blood is gathered in the Auricles, and as it diſtends them, their muſcular Fibres propel it towards the Orifices of the Heart; for they can't propel, with Force, the Blood againſt its Orifices, unleſs the cardiack Nerves be ſtrongly compreſſed. This Preſſure will cauſe a Palſy in its Nerves; conſequently the Partitions of the Heart will have no more Action; they will not then reſiſt the Action of the Auricles that propels the Blood; thus a Dilatation will there happen;

but as ſoon as the Blood will have entered into the Ventricles, the Matter which extends the Nerves, and was gathered at the entry of the Heart, will enter with Violence; then the Fibres of the Heart will ſtraiten their Cavities, will preſs the Blood, will make it ruſh out thro' the coronary Veins; thus the Heart will become pallid; during this Contraction the Nerves of the Auricles which were emptied permit the venal Blood to enter; by degrees the Heart begins to be compreſſed, the nervous Matter is heaped in the Nerves of the Auricles, they contract and render the Heart paralytic by their Contraction; thus the Heart muſt fill anew; this is the moſt reaſonable thing that can be ſaid on the Cauſe of the Motion of the Heart; we ſee hence what we may judge from the Ferment that *Vieuſſens* placed in the Orifices of the Veins that open in the Ventricles.

After having ſeen the Cauſe of the Motion of the Heart, we muſt examine its Pulſations. 1*ſt*, In the Dilatation the Partitions of the Ventricles are diſtant, and the Point approaches from the Baſis. 2*dly*, During the Contraction the Point is diſtant from the Baſis, and the Partitions return to the Diſtance where they were before. From all this it evidently follows, that it is not during the Dilatation that we muſt perceive the Pulſation of the Heart, and that they ought not to happen but when the Contraction follows: I don't know what *Bergerus* would pretend to, when he ſays, that the Point of the Heart which is hanging riſes again, the Heart is no ways hanging, it is placed on the Diaphragm that ſupports it.

There are ſome Anatomiſts who imagined that the Point of the Heart was twiſted by the Poſition of the ſpiral Lines, which they have ranged according to their fancy ; when the Heart opens, they ſaid, theſe Spirals being hal'd about ought to ſhorten it ; but when it contracts, the Point elongates, becauſe the Spirals retake their firſt ſituation: This Action of the Point that advances, cauſes the Pulſation, according to them ; but neither the Structure, nor Experience favour this Opinion, the Point is diſtant from the Baſe during the Contraction ; we have nought to examine but the Action of the Heart, we ſhall ſee that as there is ſome reſiſtance in propelling the Blood, it flows back towards the Ribs the ſame as a Cannon runs back on its Carriage, when it is fired: It is therefore in being diſtanced and running back that the Heart beats aginſt the Ribs: Let us now look into the rapidity with which the Blood is propelled by the Heart; but as this depends on the Quantity of the Blood which is in our Body, let us examine to what it is reduced.

The Quantity of Blood.

Various have been the Opinions concerning the Quantity of the Blood which is ſhut up in our Body ; commonly it is ſaid it amounts to 25 Pound, *Rolfink* reckons it 30 Pound, *Harvey* ſays but ten, *Moulin* is of Opinion that there is but eight ; his Reaſon for it is this ; in a Sheep, ſays he, I found but five Pound and a $\frac{1}{4}$ of Blood, in a Lamb I found but a Pound and a $\frac{1}{2}$, for the Blood of the Sheep was $\frac{1}{22}$ of its weight, and that of the Lamb $\frac{1}{21}$; for if the ſame Proportion is found between the Blood of the Man and that of the Lamb, it will follow that a Body that will weigh 160 Pound will have but eight Pound of Blood ; let us ſee what might have occaſioned theſe different Opinions.

Thoſe that would have determined the Quantity of Blood which is in our Body, regarded nothing but the Blood which iſſues out of its Veſſels by Hemorrhages; but to find a certain Rule there, it is neceſſary that all the Blood ſhould ruſh out of the Body by theſe Hemorrhages; let us ſee if this can happen.

Let us open the right Iliac Artery, what muſt there happen after this Inciſure? 1*ſt*, The Blood which will flow from the Heart will iſſue thro' that Orifice. 2*dly*, There will enter but very little in the Ramifications which are at the ſide of the large Trunk of the inferior Aorta; for as the Blood will find leſs reſiſtance at the Orifice, almoſt all will go there. 3*dly*, The Blood which will be in theſe lateral Arteries will have but very little Motion. 4*thly*, That which will be in the Veins, will be propelled but weakly. 5*thly*, But very little Blood will mount into the Brain, whence it follows that the Nerves will receive no more the Matter that extended them, as before. 6*thly*, There will mount leſs Blood in the Arms; for the reſiſtance which is met in the ſuperior Extremities is greater than that which is found in the inferior Aorta. 7*thly*, From all this it follows, that the Blood will be but weakly propelled towards the Heart; thus vital Motion will ceaſe before all the Blood be emptied.

Mr. *Keil* ſays, as the Canals which are in the human Body, can't be dilated all at once without being broke, no more can they return ſuddenly to their firſt State and Form, we know not what he means: We ſee that the Arteries dilated by the Heart are re-eſtabliſhed ſuddenly in Maladies where the Pulſe is extremely quick; neverthele ſs it is by this Explication that this Philoſopher pretends to ſhow that by the great open

Arteries there muſt iſſue leſs Blood than during the Hemorrhages that happen to the Noſe, hemorrhoidal Veſſels, *&c.* The Reaſon of this is, that there ſcarce enters any Blood in the other Arteries; when one great Artery is open then all the Parts muſt be in Inaction, juſt as when we tie them; all theſe Deflexions demonſtrate, that we can't judge of the Quantity of Blood that is found in a Body by the Hemorrhages.

If the Authors that have advanced that there was ſo little a Quantity of Blood in the human Body, conſulted the Lights of Philoſophy and Mechanics, they would have made the Maſs of our Blood a little more conſiderable; but for that there would have been no need even of Reaſon, they might have only conſulted Books of Obſervation. *Schenkius* teaches us, that a Man bled two Pound of Blood every Day, during a Month and a half, thro' the hemorrhoidal Veſſels, and that at laſt he was cured. *Argolus* ſays, he ſaw forty-eight Pound of Blood run out of the Noſtrils of a Patient in the ſpace of three Days. In the Tranſactions of *Leipſic*, it is ſaid, that a young Man in the ſpace of ten Days, bled through the Noſe ſeventy-five Pound of Blood.

To ſhew the Folly of thoſe that thought there was but a ſmall Quantity of Blood in the human Body, we have nothing to do but to mind Tranſpiration; it amounts commonly to $\frac{5}{8}$ of the Aliments that we take; for let us ſuppoſe that that with which the Perſon is nouriſhed, mounts to eight Pound, and that his Blood mounts to twenty: By that which we have ſaid, the Matter which will tranſpire will amount to five Pound; and as there goes from the Blood as many Exhalations in proportion as from thoſe Aliments, it will happen that the Evaporation of the Blood will amount every day to four Pound. According to this Calculation, the Maſs of Blood will change intirely in five Days, and in eight Months we ſhall have loſt our Blood forty eight times; but is there any likelihood of this? It is neceſſary that there be more Blood in the human Body, and that it be not ſubject to ſo many Alterations. It was thought formerly that the human Body changed every ſeven Years, but this is groundleſs, the ſolid Parts change not, the Wounds made during Infancy remain in our old Age; Marks that Gun-powder leaves when it burns the Skin remains all one's Life-time; if the Parts that received theſe Marks exhaled, there would, at laſt, no Spot be ſeen.

To determine the Quantity of the Blood contained in the Body, Dr. *Keil* would deduce Reaſons from the Partitions of the Aorta and Blood; he believed, that all the reſt of the ſolid Parts could be in regard of Fluids, as the ſolid Matter of the Aorta in regard of the Blood it contains, and to prove the Truth of it, to weigh the human Body, and to divide the ſum of its weight into two Numbers, that were, the one to the other, as the Blood of the Aorta to the Partitions, but this Calculation is falſe; for let us ſuppoſe a cylindric Duct filled with Water, whoſe Diameter is eight, and let us then take four, whoſe Diameter is two, if, I ſhould ſay, that the Duct, whoſe Diameter is eight, is, in regard of the Water with which it is filled, as one of the ſmall Ducts in regard of that which it contains, it would be a Miſtake, for leſs Water is neceſſary to fill theſe four Ducts than to fill the others; this is evident by the Doctrine of Proportions; for we may ſay the ſame thing of all this Maſs of Veſſels found in the human Body, and the more the Veſſels are ſubdivided, the leſs Fluid is there contained in their Cavity. Dr. *Keil* had another Method of determining the Quantity of the Blood; he dried different Parts of the human Body, and after having compared the Weight of the dried Parts with the Weight of the ſame Parts not deprived of their Fluids, he believed he had found the Proportion of the ſolid and fluid Parts of the human Body; but that Calculation is not juſt, the Parts vary very much, their Veſſels are not equally large, the one has many Membranes, the others many ſanguinary Veſſels, all this hinders our finding a juſt Proportion between the Solids and Fluids; beſides, the Fluids of our Body become Solids by heat; we muſt firſt obſerve that the Fluids compoſe the largeſt Part of our Body, for the ſolid Parts are reduced into almoſt nothing when the Fluids are evaporated; let us obſerve the Velocity with which the Blood flows through our Bodies.

The Rapidity of the Blood.

The Arteries are divided into an infinite number of Ramifications, in ſuch a Manner that all the Ramifications taken together form a Cone, whoſe Apex is toward the Heart, the Veins form ſomething like it; hence it follows that the Motion of the Blood will diminiſh very much in the arterial Extremities, for the Canals of theſe Ramifications taken together form a Space more conſiderable than that which forms the Cavity of the Aorta; thus the Blood paſſes from a narrow Place into a wider, conſequently the Rapidity will diminiſh very much. The Extremities of the Ramifications diminiſh always in bulk, thus if we obſerve one arterial Canal, we muſt allow that the Blood there requires ſome Velocity; to determine this Velocity we muſt regard, 1*ſt*. The Diminution of the Velocity ariſing from the Diviſion of the arterial Veſſels. 2*dly*. The Velocity the Blood may acquire in flowing into the ſame Duct from a large Canal into a narrow one.

In theſe Fluids that flow into Ducts propelled by the ſame force, and in equal Quantity, the Velocity is proportioned to the thickneſs of the Ducts; thus becauſe the Cavity of the Arteries is to the Cavity of Veins as 100 to 200, the Velocity in the Arteries will be greater than in the Veins.

When a Liquor is divided to run into many Ducts, its Velocity diminiſhes in Proportion to the Canals it enters; for the Cavities of the Ramifications of the Aorta taken together are at the Cavity of the Aorta as 1000 to one, thus the Velocity of the Blood will be a thouſand times greater in the Aorta; but we muſt ſubſtract from it the Augmentation of the Velocity which happens, becauſe of the Diminution of each Ramification; the ſame will hold good in the capillary Extremities of the Veins, if it were not, perhaps, that they were more numerous than thoſe of the Arteries, or that their bulk were not to that of the arterial Extremities, as the large venous Trunks are to the arterial Trunks, then the Blood would not flow there in the ſame Proportion we have been ſpeaking of, as may be ſeen by what we have already ſaid.

The Velocity of the Blood in the Aorta may be determined in the following Manner. 1*ſt*. The Velocity with which any Fluid ruſhes out of an Orifice by an uniform Motion, is equal to the Velocity of a Body that runs over a Space equal to the length of a Cylinder, whoſe Baſis is as that Orifice, and height as the Quantity of the Fluid ruſhing out in the ſame time. 2*dly*. We may ſuppoſe that in a Minute the Heart beats eighty times, and that at every Pulſation it ſends an ounce of Blood into the Aorta. *3dly.* An ounce of Blood is equal to 1.659 Parts of an Inch, conſequently eighty Ounces will amount to 132 Inches, and 72 decimal Parts of an Inch. *4thly.* In a Man of a midling ſize I found the Diameter of the Aorta equal to 73 Parts of an Inch, thus it was equal to 0.4187. *5thly.* If we divide by this laſt Number, the ſum of the ounces of Blood that ruſhes out in one Minute, *i. e.* the Number 132. 72. which expreſs the extent of that Blood meaſured by Inches, we ſhall find that the Cylinder will be 26 Inches long; but as the Diaſtole of the Heart takes away two thirds of Time at every Pulſation, the ſwiftneſs of the Blood will be found tripple, ſo that in one Minute it runs over ſeventy eight Feet.

This is the ſwiftneſs of the Blood in the Aorta; it were neceſſary we ſhould determine it in the other Arteries, this is eaſy, when we know the ſum of the Ramifications; but as it is difficult to determine it exactly, we cannot calculate juſtly: Nevertheleſs it has been proved that the Ramifications of the Aorta were in regard of the Trunk ariſing from the Heart as 1000 to 1; thus if the Blood in one Minute runs in the Aorta ſeventy eight Feet, there will flow in their Ramifications but a 1000 Part of that Space; hence we ſee the extraordinary ſlowneſs of the Blood in the extreme Ramifications; as for what regards each Ramification in particular, the Rapidity will there be greater or leſs according to the Diameter, which varies very much.

It is not neceſſary to enter into ſtill a farther Account of the Swiftneſs of the Blood, theſe general Rules may ſuffice; but it is neceſſary to know the changes of Velocity which may be produced in all the Veſſels by the Blood's flowing thro' an open Artery or Vein; we are going in a few Words to give ſome Rules thereon. Let us open a Vein continued to the *Aorta deſcendens*, I ſay, that the Blood which will flow thro' the deſcending Artery will have more Motion in reſpect to that which will flow in the ſuperior Artery than when the Veins were not open; for a Body communicates leſs Motion than it received, if it finds leſs Reſiſtance, for the Blood that flows thro' the inferior Aorta, finds leſs Reſiſtance, ſince the Orifice made at the Vein gives a freer Paſſage to the Blood propell'd by that of the Aorta: *Bellini* demonſtrates this Proportion, in ſaying that the Blood coming from the Heart finds an Obſtacle in that which precedes it; for that which precedes the Blood of the inferior Aorta when we open the Vein, is in a leſs Quantity, and conſequently reſiſts leſs, *&c.*

If we open a venal Ramification that comes from the right Iliac, I ſay, that the Blood which will flow thro' the right Iliac Arteries, will have more force than that which flows thro' the left Iliac, for it will communicate leſs Motion to that which precedes; this is proved here in the ſame manner as the preceding Propoſition.

While the Blood flows thro' an inferior Vein, I ſay, that the Motion of the Blood which flows into the right axillary Artery, is in regard of that of the left Axillary as it was before; for there is nothing that diſorders the Proportion of theſe two quantities of Blood, it finds the ſame Obſtacles in the one and the other Artery.

An inferior Vein being open'd, I ſay, that there flows much leſs Blood than before thro' the aſcending Arteries; for the Blood, in ruſhing out of the heart, is thrown in a greater Quantity into the inferior Veſſels, if it there finds leſs Reſiſtance,

ance, for it finds leſs Reſiſtance in the *Aorta deſcendens*, if the Vein be open.

When a Vein is open, the Blood of the Veins which terminates in that Vein from the Orifice to the Heart, flows with greater Velocity; for the Blood that flows into a Vein reſiſts that which is thrown there thro' the lateral Veins; the more abounding this Blood is, the more it reſiſts, but it is leſs abounding than before from the Orifice of that Vein to the Heart; that which will come then thro' the lateral Veins, will find leſs Reſiſtance, and, conſequently, will flow with greater Velocity. The Blood which flows from the Orifice of that Vein we have been ſpeaking of, to the Heart, is in leſs Quantity, conſequently in the Veins that carry the Blood from the Head, the Blood will deſcend with more Velocity, for that which comes from below reſiſts it leſs: To underſtand this Propoſition well, we muſt remember that the *Vena Cava* inferior, and the ſuperior, are continued, that they are open in the right Auricle by a ſlit, ſo that the Blood coming from below, is thrown againſt that which comes from above: *Bellini* ſays, that if the Motion of the Blood which comes from above was extreamly ſtrong, it might ſtop that which comes from below, but the Structure ſhews that this cannot happen. Let us open a Vein, I ſay, that the Velocity of the Blood which flows into that Vein, and Artery anſwering to it, is greater, in reſpect to that of the Blood which flow'd before in the ſame Veſſels, than that of the Blood of other Veins and Arteries in reſpect to the Velocity of the Blood that did flow there before we had open'd the Vein of which we ſpeak; we may prove this in general by reaſon the Augmentation of the Velocity of Blood is larger in Places where the reſiſtance is leſs; for it is leſs in the open Vein, and in its Artery, than any where elſe.

The Veſſels are emptied when the Vein is open, they are then more extended than before, conſequently they reſiſt not ſo much the force which dilates them, the Heart will find therefore leſs reſiſtance in the Veſſels. If we ſhut the Vein, the Blood will be there heap'd till that Trunk be as well diſtended as the others, and then the inequality of the Velocity will ceaſe; but as the Heart finds leſs reſiſtance, as we have ſeen in the preceding Propoſition, the Blood will flow ſwifter after the Bleeding than it did before; but it will flow leſs rapidly during the Bleeding, for the reſiſtance is greater. If the Orifice of the Vein is large, there will come out more Blood than if it were ſmall, conſequently the Blood that comes after, finding leſs reſiſtance, flows there with greater Velocity; but if any where elſe there were a Vein equal to that of which we ſpeak, and that one ſtrange Preſſure augmented the Velocity of the Blood there, as much as the Diminution of Reſiſtance augments in this here, then all would be equal.

The Pulſe becomes weaker during bleeding; the Reaſon is evident, the force of the Pulſe depends upon the quantity of Blood, and force of the Heart, for the quantity of Blood diminiſhes thro' bleeding.

By all theſe Propoſitions we ſee the reaſon of what we call *Revulſion* and *Derivation* in the Practice of Phyſick; if we would diſcharge the ſuperior Part of the Body, we muſt open the Veins of the inferior Extremity; if the inferior Part, we muſt open the Veins of the ſuperior Extremity.

After having ſpoke of the Velocity of the Blood, we muſt ſay ſomething concerning the force of the Heart, which is the chief; *Borelli*, who calculated it, made it amount higher than the force of a Weight of 135000 Pounds, but all his Calculation is ſupported by falſe Hypotheſes, which I ſhall paſs by unobſerved, becauſe this would carry me too far from my Purpoſe. Dr. *Keil*, who would reform this Author, makes it not amount to more than five Ounces by the firſt Method he makes uſe of; but in this Method he builds upon a Rule of which *Bernoulli* ſhew'd the falſity: As for the ſecond Method, that is more exact, there are, nevertheleſs, many Things to be contradicted. As I cannot enter into Particulars without the help of a long Calculation, I will not ſhew the Defects of this ſecond Method, which does not agree with the firſt, for it makes the force of the Heart to amount to eight Ounces; we can't exactly determine Things of this Nature, becauſe we muſt always frame Hypotheſes which may be diſputed: The geometrical Diſputes made thereon will never prove any Thing whilſt we have no fix'd Points on which to ſupport ourſelves; we may, nevertheleſs in general ſhew, that the force of the Heart is very great. 1*ſt*. All the Arteries in the whole Body reſiſt the Heart, which is, in the leaſt, as 1000 to 1, in reſpect to the Aorta. 2*dly*. The quantity of Blood in the Arteries is very great, for the Heart muſt propel all this Blood, which amounts, at leaſt, to eighty Pounds in thoſe that weigh an hundred Pounds: I comprehend in this Calculation all the Fluids in the Body, and which are propell'd by the force of the Heart. 3*dly*. The Muſcles which compreſs the Veſſels, are in a great Number, and have a great Force——from all this it follows, that the Heart, which ſurmounts all theſe Reſiſtances, muſt have a very conſiderable Force, which will appear ſtill greater, if we reflect, that notwithſtanding all theſe Obſtacles, the Heart propels the Blood into an infinity of Turnings, which multiply the Reſiſtances at every inſtant throughout the whole Body.

The Nature of the Blood.

We are now to obſerve the Nature of the Blood; we obſerve in that Fluid, 1*ſt*. Red Globules. 2*dly*. Fibrous Particles. 3*dly*. White Globules. 4*thly*. A great deal of clear Water that ſerves as a Vehicle to all theſe Subſtances. The red Globules differ not from thoſe found in the Chyle, but in their being compoſed of many Globules, their Colour depends only upon that Coheſion, for when ſeparated from one another they receive again their Whiteneſs; hence all that appears red in Blood expoſed to the Air, is turn'd at laſt into Serum; for the Globules, which ſeparate one from the other, receive their former Whiteneſs: the ſame thing happens in Abſceſſes, the extravaſated Globules of Blood are continually ſtruck by Veſſels, aided by the great Heat which neceſſarily follows, that divide the Parts of the Blood.

The Cauſe of this Redneſs has occaſion'd the forming of ſeveral Syſtems; the moſt generally received here, was the Mixture of nitrous Particles of the Air with the Blood in the Lungs; ſome chymical Experiments ſeem to confirm this Idea; but firſt, with alkaline Salts we may redden Milk, What Reaſon ſhall we then have to attribute this Colour of the Blood to the nitrous rather than the alkaline Salts? We may with the ſame likelihood ſay, that a lixivious Salt out of the Earth, or mix'd with the Aliments, produces the redneſs, when it is alkalized by the Heat of the Body; beſides, can't we as well find in the Air ſome Mine of Salt-alkalious Nitre? 2*dly*. We can't prove that there is Nitre in the Air, the nitrous Subſtances form'd on Walls prove nothing; on the contrary, we may draw a Proof againſt this Opinion; for it is not conceiveable that in the Air there ſhould be found ſo large a quantity of Nitre; beſides, if we take an Earth which is the Baſis of Nitre, and expoſe it in a place where this Salt is form'd, immediately this Matter is fill'd with nitrous Acids; but ſome diſtance from thence the ſame Earth will remain unuſefully expoſed to the Air, and ſhall not change into Nitre; whence proceeds this difference, if the Nitre be expanded in the Air? We ſay that the Earths from which Nitre has been taken, and drawn out, afford again this Salt, when they have been expoſed to the Air; this is true, if there is there form'd an unfolding, and that the Air furniſhes it but with its Action; this is ſo true, that after having continued expoſing this Earth ſome time to the Air, we can't get any more Nitre out of it: Beſides theſe Reaſons, we have one more conſiderable that will not allow us to give much Credit to ſuch an Opinion, becauſe, *viz.* all that is ſaid upon it is Hypotheſis, and grounded upon no Experiment.

I ſhall not here take notice of thoſe who formerly attributed the redneſs of the Blood to the Liver; we know that *Bartholin* gave a Deſcription of this *Viſcus*, but, I believe, we may render him in part the Functions we once refuſed him; it is not proved that the Chyle paſſes not thro' the meſeraic Veins into the Liver; on the contrary, we know it to be ſo in Birds. Experiments even, as we have ſhewn, ſeem to prove that the ſame is found in Man; if ſo, we can't deny that the Blood don't become red in the Liver, for it paſſes thro' the Strainers of the Veſſels of the *Vena Porta*; in theſe infinitely ſmall Ducts the Globules of the Chyle may be preſſed, and ſtick the one to the other, by the Motion and Preſſure propelling them from larger into narrower Paſſages; at leaſt we may maintain that in the Extremities of the Veſſels of the *Vena Porta* the chylous Globules are diſpoſed to take the red Colour; but be it as it will, we can't doubt that in the Extremities of the hepatic Artery the Chyle receives not the ſame change as it does in the other *Viſcera*, ſince it paſſes thro' the ſame Strainers which preſs it with force. According to what we have juſt now eſtabliſhed, all the Parts of the Body give the Chyle a red Colour, for every where there are found capillary Extremities; in theſe Extremities the moſt fluid Parts paſs the firſt, becauſe they flow the eaſier; the Globules that are nearer one another, becauſe they form the groſſeſt Parts of the Chyle with the Filaments, are propell'd one againſt the other by the Motion of the Heart and Arteries: From this Preſſure follows the adherence which is found between them both, for the Union of the Parts of the Body depends not but by the greatneſs of the Surface, by the which they touch one another; for thro' the Preſſure mention'd the Globules flatten on the ſide that they meet; thus the Places that touch one another can be large, conſequently the Union may be very ſtrong. But how is it that the united Globules can take the red Colour by this Union preciſely? It was ſaid, that Colours conſiſted in the Modification of the Lights, but by reiterated Experiments we were at laſt convinced that Colours are particular to certain

Rays of Light, ſo that the Objects don't ſeem colour'd but by the Reflexion and Refraction of the Rays; this Action of Bodies on Light depends from the Diſpoſition of the Parts of theſe Bodies, which we can't determine.

The Globules in the large Veſſels tincture all the Fluids that are there found red, it is not therefore neceſſary that they be in a great Quantity; we ſee that a little red Wine tinges a large Glaſs full of Water; this will appear ſtill more ſolid, if we conſider that the greateſt Part of Wine is aqueous. As for the Blood, Experience ſhews us that Water and Lymph are more abounding than the red Fluid; for as ſoon as the Blood is expoſed to the Air, the Globules are heap'd up in a Space very ſmall in regard to that which the Serum occupies; beſides, if we evaporate the Water from the red Part ſeparated from the reſt, we ſhall ſee that there is but a little red Matter.

The ſmall quantity of red Globules makes the capillary Extremities of the Arteries to be diſcolour'd; for as theſe Globules can't paſs but one after another in the Strainers, it follows that there be for one red Globule a large Quantity of Water and Lymph, and by that means the red Colour muſt be abſorbed; the more theſe red Globules are compreſs'd, the more their Figure ought to change; thus the Colour muſt ſuffer ſome change; we have alſo obſerved that the Globules in paſſing thro' the arterial Extremities flatten, and take a yellowiſh Dye; we perceive ſmall white diaphanous Globules which are nothing elſe but the oily Parts of the Lymph which have neither as yet Motion nor Preſſure enough to change their Colour.

The redneſs of the Blood is not abſolutely neceſſary, for we find Inſects that have nothing in their Veſſels but a whitiſh diaphanous Liquor;

by this Fluid they live, they perform all the Motions their ſmall Muſcles are capable of; we may therefore conclude that the redneſs of the Blood is not neceſſary in all Animals: In Man and other Animals, whoſe Maſs is not inſenſible, this Colour is not neceſſary, but the Cauſe producing it is abſolutely ſo; this Cauſe is a violent Motion in the Fibres, without this Motion Circulation and Nutrition could not be perform'd. In inſenſible Inſects, where the Microſcope diſcovers to us white and tranſparent Fluids, the Membranes which are of an infinite fineneſs, have no need of a violent Motion to diſtribute for them the nutritious Juice, and to apply it to their Fibres in order to repair the Loſſes of Tranſpiration.

The Blood has not the ſame Colour in all theſe Veſſels; if we open a Dog immediately after he has eat, we ſhall find in the pulmonary Artery a whitiſh Fluid mix'd with the Blood, but in the Veins the Blood is moſtly red; the redneſs of the Blood depends on the Coheſion of the Globules of the Chyle; theſe Globules by the Preſſure they have ſuffer'd have been united in the capillary Arteries, therefore the Blood is redder in the pulmonary Vein than in the Artery. There is ſtill another difference of Colour in the Blood found in different Veſſels, the arterial Blood is very red, but the Venal is blackiſh, this flows from the ſame Reaſon we have already mention'd; the redneſs of the Blood depends upon the Motion which is leſs vehement in the Veins, and therefore muſt alſo produce leſs Effects; but there is another Reaſon which proves better that this difference muſt happen, *viz.* that the arterial Blood is filled with Lymph, whereas the Venal is deprived of it; conſequently the red Globules are *cæteris paribus* in larger Quantities in the Veins, and the Blood muſt there appear deeper and blackiſh. But this Reaſon leads us into no ſmall difficulty, we have ſaid that the Lymph is in a ſmall Quantity in the Veins, it will then follow that it ſhould condenſe more eaſily than that of Arteries; nevertheleſs we ſee to the contrary, for in the Veins of a *Cadaver* the Blood preſerves its fluidity for a long time, but that which is in the Arteries and Ventricles of the Heart condenſes in a ſhort time; this Difficulty, which appears at firſt ſight to overturn our Anſwer, doth but confirm it; as ſoon as the vital Motions ceaſe the Blood is not preſſed in the Arteries, but by a ſmall remain of Contraction which proceeds from the Spring, this Preſſure is not ſtrong enough to make all the Blood paſs; thus the red Globules find not free Paſſage in the capillary Veſſels, for which Reaſon the Preſſure of the Arteries lets the moſt fluid Part immediately paſs into the Veins, the larger Parts, *i. e.* the Globules remain partly in the Arteries; it is neceſſary therefore that the arterial Blood be condenſed: As for the venal Blood, as it is found compoſed of globular Parts of the fineſt form, and of a great deal of Water, it will be fluid; beſides, for the ſame Reaſon the fibrous Part which contributes more than any thing to the Condenſation, is found retained in the Arteries, becauſe of its coarſeneſs.

When we draw Blood from the Veins and Arteries of the ſame Animal we obſerve a difference; the Blood of the Arteries has almoſt the ſame Colour in the ſurface as at the bottom, but the venous Blood is very black at bottom (ſuppoſing this Blood to be put in Veſſels of ſome depth) the difference of the Blood proceeds from nothing but the Rarefaction and Diviſion of the arterial Blood more than the venal; the Motion in the Arteries, which is not in the Veins, muſt neceſſarily produce this Effect; this being ſuppoſed, the ſurface of the Blood muſt be red, and the bottom blackiſh, for the Globules are the cauſe of the redneſs of the Blood, for there are none red but them. Theſe Globules are mix'd with the fibrous Part, which being a little heated in the Veins condenſe, for in condenſing it precipitates, and brings along with it a large Portion of Globules; beſides, theſe Globules thus condenſed deſcend in great Quantity by their weight, and ſo leave their ſurface; hence it follows, that the Globules are in a great Quantity at the bottom, and very few at the top; the Colour muſt then be blackiſh at the bottom, for the extremely deep red Colour draws on the black, and it is deeper when a larger number of red Globules are join'd together; this is ſeen in the venal Blood, as we have obſerved; we may prove what I have ſaid concerning the condenſation of the Fibres of the Blood, by the Serum that ſwims upon the ſurface ſome time after the Blood has been expoſed to the Air; beſides, if you put any quantity of Blood in a deep Veſſel, not diaphanous, the inferior Part will ſeem deep colour'd, tho' in reality it is not ſo, becauſe all the redneſs proceeding from the inferior Surfaces paſs thro' the ſuperior, which it could not poſſibly do, if there were not a great number of Rays joyn'd together, and conſequently it is deep colour'd; on the contrary, if you put Blood in a very large Veſſel, but not deep, even the venal Blood will appear bright, becauſe there cannot be too great a number of Globules in a ſmall Space, for there can be no Precipitation to draw away ſo great a Quantity: Hence it appears, that the Perſon who bleeds may make the Blood appear black or red. What we have ſaid of Blood put into a large and deep

Veſſel, will hold good in Blood which runs *guttatim*; for the ſame Cauſe which gives a bright red to the former, gives it alſo to the latter.

As for the arterial Blood, the bottom of that cannot become blackiſh, as in the venal; the fibrous Parts are extremely rarefied; thus they don't condenſe ſo much as the fibrous Parts of the venal Blood, which being already come nearer one another in the Veins, muſt unite more intimately than thoſe of the arterial Blood by the Action of the Air: Hence it follows, that there will not be ſo much Precipitation in the one as in the other, this is alſo confirm'd by Experience, for the arterial Blood affords not immediately ſo much Serum as the venal.

There is an Author who pretended that the Blood of the pulmonary Vein ſhould be condenſed, becauſe it is arterial; but what can be ſaid of the Blood in the other Veins ought to be attributed to the Blood of the pulmonary Veins, it having undergone a great Trituration in the Strainers of the Lungs, it has there been ſtrip'd of a Part of the Lymph, as in the other arterial Extremities; What difference muſt there then be between the Blood of all theſe Veins? I don't ſee that there can be any, unleſs it is the coolneſs of the Air that condenſes it a little: Let us judge hence if we ought to believe that the pulmonary Vein is not leſs than the Artery; but becauſe the Blood is more condenſed, the Blood that returns thro' the emulgent Veins was deprived of the Lymph, it ſhould then occupy leſs Space, and conſequently the Vein ſhould be leſs; nevertheleſs we don't find this to be true; beſides, Why ſhould we look for ſo diſtant Cauſes? We may here only reflect, that in the *Fœtus* the Blood can't paſs but in a very ſmall Quantity in the Veins, whereas it is continually propell'd in the Arteries by the Heart; it is therefore neceſſary that the Arteries dilate much, whilſt the Veins dilate but a little.

Beſide the red Part of which we have been ſpeaking, there are fibrous Parts in the Blood; ſome Anatomiſts have denied the Exiſtence of theſe Parts, but if we throw ſome Drops of Blood, juſt drawn, into a Veſſel full of Water, there will be a Part which will expand on the Surface of the Water as Oil, and we ſhall, at the ſame inſtant, ſee Filaments that will precipitate; this appears very plain in Blood taken away from the Foot, for the red Part mixes with the aqueous Parts, but the gelatinous Part appears fibrous. The Microſcope diſcovers the ſame thing; for if we but conceive on the ſurface of a Glaſs a drop of Blood which comes from the Veſſels, and we ſhall immediately ſee that there are Filaments, which having loſt the Heat which rarefied them, cohere the one to the other; theſe are the Parts that form the membranous Subſtance which is upon the Blood when heated; this Subſtance is not thicken'd but by the Action of the Particles of Fire, which having evaporated the moſt fluid Parts, leave the groſſer Parts without a Vehicle; theſe thick Parts, in Proportion as they loſe the Fluid that ſeparated them, muſt approach one another, and unite by the force of the Atmoſphere. We may raiſe a Difficulty againſt this Explication, *viz.* we obſerve, that if we put Blood into hot Water, the gelatinous Part thickens and becomes membranous; we can't nevertheleſs ſay, that this Matter loſes then its fluid Part, becauſe it ſwims in Water; but we are here to obſerve, that the Fluid which divides theſe Parts, and ſerves them as a Vehicle, is the Air in par-

ticular,

ticular, for when we put Blood into hot Water, the Air rarefies, and leaves the Interſtices of the fibrous Parts; as thoſe Parts mix not eaſily with Water, they will be preſſed by the aqueous Particles; thus they muſt approach and unite; we ſee an Example of this in Eggs which are put in hot Water; by the Heat the Air diſengages from the white and is gathered at the Extremities; beſides, the extremely volatile Parts that ſerve as Vehicles to the groſſer, hinder the fibrous Parts from uniting immediately, for by that heat of the Water theſe volatile Parts exhale, and leave only the fibrous Parts, which not being able to be penetrated by Water, becauſe they are oily, muſt approach and unite.

Bohn imagined, that the Fibres we have been ſpeaking of, were only found in the extravaſated Blood, and that they were not form'd but by the Condenſation of the glutinous Parts; but this Opinion does not ſquare with the Obſervation made by the Microſcope in the Veſſels, for we clearly ſee that there are in the Blood ſmall Filaments; theſe Filaments, indeed, do not appear ſo numerous as in the extravaſated Blood, becauſe the Rarefaction divides them more.

Thoſe who denied that there were fibrous Parts in the Blood, have grounded their Opinion partly on the Danger of the Arteries being ſtop'd by theſe Filaments in the capillary Extremities; but as they are mix'd with a great deal of aqueous Matter, and that the Heat rarefies them very much, we muſt not fear this Inconvenience; nevertheleſs, they may cauſe many ſad Accidents if they are in too great a Quantity, they can, *v. g.* occaſion Pleuriſies and Peripneumonies; even Rheumatiſms are often nothing elſe but the Effect of theſe Fibres that choak up the very ſmall Veſſels that are in the Ligaments of the Joints; what happens to theſe Fibres, when we heat the extravaſated Blood, happens to them, when in the Body there is too great a Heat; they re-unite, and form a white Cruſt, which we ſee in the Blood of Pleureticks.

The fibrous Parts, when the Blood is expoſed to the Air, re-unite, and often form a conſiderable Maſs; this happens, eſpecially, when the Blood is very much deprived of its aqueous Part, then theſe fibrous Parts, re-united, form a kind of Rays of Honey by their union.

Amidſt all theſe fibrous Parts which form a ſort of Net-work in the extravaſated Blood, we obſerve ſmall white Globules; theſe are but the gelatinous Parts, the moſt fluid being preſſed by the aqueous Part of the Blood on all ſides, are obliged to be round: Theſe Globules differ not from thoſe which form the red Part, but in that they are ſimple, whereas the red ones are compoſed of many, fix'd the one to the other; theſe ſimple Globules, by reiterated Circulations, can, at laſt, become red; this follows of what we have eſtabliſh'd on the Circulation of the Blood.

All theſe Subſtances that compoſe the Blood are agitated by two Motions; as they pretend the one is the Motion of the Circulation, which we mentioned; and the other the inteſtine Motion, *i. e.* the Motion of the ſanguinary Parts in general.

As for the Motion of the Circulation we have ſaid enough on its Cauſe and Exiſtence; we have but one Thing to add, and it follows evidently from what we have proved, *i. e.* that the Parts of the Blood being very different, the Motion the Heart impreſſes on them muſt be alſo very different; the moſt proper Parts for Motion muſt occupy the centre of the Veſſel, but the others muſt be thrown on the ſides; it is thus that in a River things that move moſt difficultly, are always puſh'd towards the Shore; it is this circular Motion that preſerves the Blood in the State it muſt be in to flow eaſily in the Veſſels; we have already proved it by a curious Experiment; beſides, we ſee that as ſoon as this Motion alters, every thing changes in the Blood: It is this Motion, which by the continual Frictions it cauſes in the Parts of the Blood againſt the ſides of the Veſſels, that excites and maintains a Heat which is neceſſary for the Preſervation of Life in Men; this Heat was attributed by many to the diſcharge of the Particles of Fire that are extended, according to ſome Philoſophers, throughout all the material World; but we may ſimply ſay, that it owes its Original to the Motion of the Parts compoſing the Bodies: Whatever we may ſay of the igneous Parts, this never will be but a Motion which will form the Heat; we do not conceive that Matter can act in another manner: Thus the Opinion of thoſe who pretend that the Matter of Fire is expanded in all Bodies, can but prove that every where there is a Matter very proper to be moved.

The inteſtine Motion is not proved as the circular Motion, on the contrary, it ſuffers many Difficulties; we do not deny that the Parts which compoſe the Blood have not different Motions in their Veſſels, their divers Reflections, the Elaſticity of the Air, the Action of the Veſſels, all this muſt impreſs divers Motions to divers Parts that compoſe the Blood; but what we deny is, that this inteſtine Motion is eſſential to its Fluidity, *i. e.* that the Blood is not fluid, but becauſe its Parts are diverſly moved: A Subſtance may be fluid, though all its Parts be in a perfect *quies*; it is ſufficient only, that theſe Parts may yield to the leaſt Impulſe, for this neceſſarily will happen when they are not united. There are none, I believe, can maintain that the Diſunion or Non-adherence of the Parts of Fluids cannot exiſt without Motion; this Opinion has not ſo many Difficulties as the other; hence we ſave the Pains of ſeeking a Cauſe of this Agitation which we thought to find in the ſubtile Matter, but nothing can prove this; we cannot conceive in this Fluid a continual Motion that carries its Parts on all ſides, the Reaſon is evident, for if we would eſtabliſh a general Motion, we muſt ſay, that there is no Place towards which ſome part of this Fluid does not move; for if this is true, there will be no part in Motion but what finds ſome other Part that will have as much force as it in its Courſe; it cannot then move itſelf, nor, conſequently, any of the other.

The Motions of Circulation and Fluidity are not the only ones that have been attributed to the Blood, they would have it ſtill allowed a fermentative Motion; the Blood, ſay they, has acid and alkaline Principles, which beating continually the one againſt the other, muſt neceſſarily produce the Motion we name Fermentation, as in Fluids that have theſe Principles; but as theſe Principles are mixed with ſulphureous Parts which ſeparate them, it follows hence, that the Fermentation ought to be perform'd by degrees: At the firſt Inſtant ſome ſulphureous Parts will iſſue out from between ſome Acids and ſome Alkalies: At the ſecond Inſtant the ſame thing will happen to other Parts, thus the Fermentation will be performed ſucceſſively; beſides, they bring many other Reaſons to prove, that in the Blood there is ſuch another fermentative

Motion. 1*ſt*. It is ſaid, that the Chyle changes into Blood, for in the Blood the Parts are changed, and the Proportion of the Principles that compoſe it, is not the ſame as in the Parts of the Chyle ; all this, according to ſome, could not be done without a Fermentation. 2*dly*. The Blood changes in different Humours ; in this Change there is one of Subſtance, which cannot be perform'd without Fermentation. 3*dly*. In Hay and Oats we find no urinous Salt, nevertheleſs, Animals that feed on theſe Subſtances afford a great deal of Salt by Analyſis, for this Salt cannot be form'd without a Fermentation no more than the *Sal ſalſum* ; all theſe Reaſons are maintain'd by the Analyſis of all the Fluids of the human Body, which I ſhall mention as the Defenders of a Fermentation, and give an Account of the Conſequences they draw from it.

The *Saliva* examin'd by Diſtillation, firſt produces Fluids that tinge the Flower of Mallows green, and turns into a white Powder the corroſive Sublimate ; hence we conclude, that the *Saliva* contains Alkalies, ſince it produces ſuch effects. 2*dly*. It gives a fœtid Oil. 3*dly*. In a Word, what remains after the laſt Diſtillation, is a *Sal ſalſum*.

They have ſometimes gathered a good quantity of ſtomachical Juice by tying the ſuperior and inferior Orifice of the Stomach in a Dog ; they ſay that theſe following Properties were obſerved in that Fluid. 1*ſt*. It was inſipid and without Smell. 2*dly*. That Acids nor Alkalies excited any Fermentation. 3*dly*. It work'd no change to the Tincture of the Mallows Flower. 4*thly*. The Diſſolution of the corroſive Sublimate became a little milky by the mixture of this Fluids ; theſe Effects being common to the ſtomachical Juice and the *Saliva*, it follows, that they muſt give the ſame Principles by Analyſis.

The inteſtine Humour could not be diſtill'd, becauſe a large quantity of it could not be gathered, but its Properties have been determined by the following Propoſitions. 1*ſt*. The Aliments are quite digeſted in the Inteſtines, the Fluid therefore that is there filtrated, may cauſe a Fermentation. 2*dly*. The Excrements muſt glide on the ſides, the ſtomachical Juice muſt then be proper to lubricate the Inteſtines. 3*dly*. The *Fæces* that are ſharp might wound the Inteſtines, it is neceſſary then that the inteſtinal Juice hinders the effect of the Acrimony of theſe Subſtances.

The relation obſerv'd between theſe three Fluids ſhould make us think they would afford the ſame Principles by Analyſis; it is neceſſary then that they be compoſed of very much Phlegm, a great quantity of volatile Salt, a little fix'd Salt and Earth.

Some have allow'd Acidity to theſe Humours, they thought they could evidently prove the exiſtence of acid Salts, eſpecially in the *Saliva*, by the following Experiments. 1*ſt*. The Tincture of Sun-flower becomes red by the mixture of the *Saliva*. 2*dly*. Mercury is fixed by this Liquor: They anſwer to theſe Experiments, 1*ſt*. That the *Saliva* tinges not the Sun-flower red, unleſs it be the *Saliva* of a ſick Perſon. 2*dly*. That the *Saliva* coagulates not Mercury in a Glaſs Veſſel; if it does in a Braſs one, the cauſe of it is the Amalgation of the mercurial Parts with the metallic.

The Bile analyſed affords, 1*ſt*. much whitiſh and urinous Phlegm that gives a green tinge to the Flower of Mallows, precipitates the Diſſolution of the corroſive Sublimate, and ferments with the Spirit of Nitre. 2*dly*. There proceeds a urinous Spirit that differs from the Phlegm in nothing but by the volatile Salts that it contains in a large Quantity. 3*dly*. There follows a ſtinking blackiſh Oil, in which there is a great deal of urinous Salt. 4*thly*. From that which remains we draw a little fix'd Salt and Earth.

The pancreatic Juice has been gathered by many Anatomiſts in pretty large quantities; it is inſipid, although *Graaf* and *Schuil* ſay it was acid; it agrees in all with the *Saliva*, as it appears by its Filtres, which are the ſame as the ſalival Strainers, therefore we need make no Analyſis.

The nature of the Lymph was enquired into by ſeveral Obſervations. 1*ſt*. It becomes, ſay they, viſcous by the action of the Cold, it contains then ſulphureous and glutinous Parts that are mixed with a great quantity of Water. 2*dly*. The Lymph expoſed to the Air, coagulates not as the Blood; this proves, ſay they, that the ſulphureous Parts they contain are more acute and divided than thoſe found in the Blood, ſince having loſt their Heat they are not coagulated. 3*dly*. If we expoſe the Lymph to the Fire, it is changed into a white Maſs; theſe are the ſulphureous Parts which being deprived of the Fluid that ſerved them as a Vehicle, are forced to approach one another. 4*thly*. If we throw Spirit of Nitre into it, it thickens, but it recovers its Fluidity if we throw in it *Oleum Tartari per deliquium*. 5*thly*. It tinges the Flower of Mallows with a green Colour.

The Seed, which is a white, glutinous, thick and fattiſh Subſtance, muſt have a great deal of Sulphur; 1*ſt*. It doth not coagulate by the action of Cold; thus, ſay they, it owes not its

Fluidity to the heat that it has in its Veſſels, ſince after being cool'd it is not leſs fluid; this proceeds not but from the extraordinary Diviſion of the Sulphurs. 2*dly.* It diſſolves eaſily in Water; this proves that the Sulphurs are extremely divided, and that there is much Salt. 3*dly.* The Seed diluted in a little Water gives a red Tincture to the Flower of Mallows, this happens to freſh Seed; but that which is kept ſome time, that, I ſay, produces a green Colour; from thence we draw this Conſequence, *viz.* that it muſt have Acids which eſcape immediately, and Alkalies that remain behind. 4*thly.* Acids thicken and coagulate the Seed, but Alkaly gives it a Fluidity. 5*thly.* As for the chymical Analyſis of the Seed, *Verheyen* ſays, that having kept the Seed of a Bull for a few days, and having put it in a Retort, he took from it a little Phlegm, ſtinking Oil, volatile Salt, and a ſmall quantity of *Caput mortuum*; from the Glands and Proſtatæ of *Cowper* there runs a viſcous Fluid, it differs from the other in its being more limpid, more aqueous, and leſs thick; there alſo flows from the Woman in Coition a Fluid much reſembling that of the *Proſtatæ* in Men; we may judge of the Principles of theſe Fluids by the Analyſis of the Semen.

The Milk and Chyle are almoſt the ſame Fluids, but the Milk is very white, ſweet, and retains almoſt nothing of the Aliments that produced it; whereas the Chyle is ſalty, and retains very much of the Aliments, and is not perfectly white: we may by the difference ſee that the Analyſis will afford ſome varieties, but the Principles that it will draw from this Fluid are uniform; Milk expoſed to the Fire, immediately gives a Phlegm, then an acid Spirit, and, at laſt, a thick and black Oil.

The Urine conſidered in itſelf, or in its Principles, has occaſion'd many chymical Ideas, 1*ſt.* It is yellow, it is therefore compoſed, as has been ſaid, of ſulphureous and earthy Particles. 2*dly.* It is ſharp, it muſt therefore have alkaline ſalts 3*dly.* When we lather the Urine, there is a Froth compoſed on its ſurface, this ſhews that there is a great deal of Sulphur. 4*thly.* It produces the effects of Soap, it contains therefore alkaline Salts mix'd with Oil. 5*thly.* It reſolves the Tumours, there are therefore alkaline Salts which cut the viſcous Humours. 6*thly.* We ſee in the Urine fibrous Parts which reunite by the Action of Cold, they are nothing but ſulphureous Parts. 7*thly.* There is precipitated a Humour which is full of ſaline Particles. 8*thly.* Freſh and warm Urine gives a red Colour to the Tincture of the Flowers of Mallows, but when it is cold, it gives it a green tinge, it precipitates alſo the corroſive Sublimate; by all theſe they would have proved there were acid Salts and Alkaly in the Urine. 9*thly.* In a word, diſtill'd Urine produces much Phlegm, a reddiſh Spirit, an empyreumatick Oil, and a volatile Salt of Alkaly. Theſe are the Ideas that made many Authors leave the Mechaniſm of a human Body to make it laboratory, but there is no foundation in all the Conſequences they would draw from the Analyſis; let us examine it more narrowly.

They ask, at firſt, Whether there is any acid in the Blood, or other Fluids? We cannot deny that this Salt is not found in them, the Aliments which we are nouriſhed by are filled with it; it is neceſſary then that this Acid be entirely changed, or be incorporated with other Principles. 1*ſt*. We cannot ſay that the Acid is entirely changed; Mr. *Homberg* demonſtrated that, beſides the Oils, as Chymiſtry teaches us, have an Acid for their Baſis. *Vieuſſens* again took an Acid from the Blood. *Pitcairn* reproaches him, and ſays he put a Bole into the Blood; which he expoſed to the Fire, and that he took the Acid of the Bole for the Acid of the Blood; but he is miſtaken in that, it was nothing but the Acid that was in the Blood, or in the marine Salt mixed with the Blood, that could be raiſed, whilſt the vitriolic Acid contain'd in the Bole took its place. 2*dly*. The Acids are changed by degrees in a human Body; this muſt not appear ſurprizing, ſince the moſt fix'd Salts, and that all our Fires, which ſcarcely alter, become volatile in our Veſſels; beſides, we know that Fire changes acid into alkaly; we have an evident Proof of it in Nitre fixed by Coals, for the heat of our Body can produce the ſame effect, this is conformable to the Experiment which teaches us that the immoderate Heat which is raiſed in our Veſſels, alkalizes our Fluids; we ſee an evident Proof of it in the Naſtineſs of dropſical Waters and corrupted Urine; this Odour is caus'd by nothing but the volatile alkaline Salts that ſeparate and ſtrike the Smell; we find a Confirmation of all this in the corrupted animal Fluids, out of which is taken a volatile alkaline Salt; for this Salt, form'd by Putrefaction; is form'd in our Body, ſince too violent Heat diſpoſes our Humours to a Putrefaction; witneſs again the Urine of a heated Body, and the dropſical Waters we have been ſpeaking of: we may add to all this the Obſervation of a learned *Engliſhman*, who ſhew'd that the Matter of Ulcers contain'd alkaline more than any other Salt.

3dly. The Acids change in the Blood in ſuch manner, that they form at laſt a *Sal ſalſum*, by the continual action of the Veſſels, and action of the Air, that puſhes the Acids into the Pores of the Alkaly. *4thly.* The Acids incorporate with the Oil of the Body, for Chymiſtry teaches us, that Sulphurs are a kind of very ſtrong Alkaly in relation to the Acids, the oily Parts muſt then join to theſe Salts.

The famous Queſtion that raiſes ſo many Diſputes in Phyſick, *viz.* Whether the Blood is acid or alkaly? may now be anſwered. *1ſt.* Blood taken from the Veins of a young Animal, taſtes neither of an Acid nor an Alkaly; on the contrary, it taſtes of ammoniac Salt. *2dly.* If we mix it either with Acids or Alkalies there is no Ebullition; from theſe two Reaſons we may evidently conclude, that the Blood is neither acid nor alkaly. The firſt Reaſon cannot be anſwered; but againſt the ſecond it was urged, that there was no Effervescence in the cold Blood mix'd with Alkalies or Acids, but there would follow ſome if the Blood were hot; but in throwing theſe Salts into the Veins, even of Animals, or in the Blood, at the inſtant that it comes out of the Body, we obſerve by that the ſmall remains of Ebullition; we may add to all this, that the Diſtillation of the Blood gives neither Acids nor Alkalies.

What we have ſaid of the Blood we may ſay of the Milk; whatever Proof we make on this Fluid by mixtures, we neither diſcover their Alkalies nor Acids, for theſe Salts produce no Effervefcence in them; we may ſay the ſame thing of the Lymph, which is very like the white of an Egg; there is no Experiment that can prove this Fluid to be acid or alkaly.

It ſeems that the Acidity which is in Milk of long ſtanding, proves it to be acid; but in this there is nothing contradictory to what we have ſaid; the Milk is nothing but a compoſition of oily Particles join'd to an acid Salt, and ſome alkalized Fluids which are not well incorporated with that Salt; when we preſerve Milk ſome time, the acids ſeparate from the oily Part, and grow ſour. If the Milk is extremely heated in the human Body, it produces a Phenomenon quite contrary to the laſt mentioned, for it becomes yellowiſh, ſour, and like Alkaly; it is a Conſequence of what we have eſtabliſhed, *viz.* that Salts are alkalized in the Body by heat. That which happens to the Milk in the Veſſels, happens to the Blood, but in a more ſenſible manner; for as ſoon as it is preſerved ſome time, and that it begins to corrupt, it changes into an alkaline Fluid which boils with Acids.

As for freſh Urine, whatever mixture is made of it with Acids or Alkalies, we diſcover nothing to ſhew it is acid, or to contain alkaly; it is certain that it contains nothing but a *Sal ſalſum ammoniacum.*

But how are we to reconcile what we have ſaid with the Experiments of which we have been ſpeaking? Did thoſe who gave them us, perform them ill, or ſpeak againſt the Truth? All this may be eaſily reconciled to that which we have juſt now eſtabliſhed; in the Blood there is an Acid, an Alkaly, and an Oil; according as theſe Fluids are joined together, or ſubtilized, they unfix, ſome ſooner, others later; if the Acid unfixes ſooneſt, that which evaporates will be acid, and what remains will be alkaly, but if the Oil or Alkaly evaporate ſooneſt, that which remains will be acid.

We find an invincible Proof of what I have ſaid concerning certain Plants whoſe Juice is preſerved ſome time; ſometimes it is the Acid that takes the upper Hand, and ſometimes the Alkaly; all this depends on the union and ſeparation of the Principles.

As for the Alterations of the Colour, 1*ſt.* They prove nothing; there is no neceſſity to bring any Proofs of it here. Every Body knows that a mixture of Alkaly produces ſometimes the ſame Colour that we attribute to Acids. 2*dly.* Accordingly as the Acid, Oil, and Alkaly will ſeparate, they will produce different Colours; we may obſerve on this Head, that the Fluids of the human Body produce not the green, or red, when they are freſh; it is neceſſary that they be preſerved ſome time, then the Acids and Alkalies ſeparate.

The Separation of the Acids, Oil, and Alkaly, is not eaſy to be explain'd, but we may ſay, that the action of the Acids on the Alkalies cauſes at laſt this Separation; the Alkalies have empty Pores, the Air puſhes by its weight the Acids in theſe Spaces which no Matter occupies; by theſe continual Motions the Acids break the Alkaly, and are free; thus they can evaporate. The Acids being evaporated, the Alkalies may raiſe and evaporate themſelves.

After all that we have ſaid, we may reſolve the Queſtion which gave us occaſion to treat of the preceding Matters, *viz.* if there is a Fermentation in the Blood. 1*ſt.* Whatever we ſay, we cannot aſſert it, the Subſtances that compoſe the Blood are very oily; and we know by Chymiſtry that Oils hinder Fermentations. The Acids of Vinegar that have diſſolved Lead, and are mix'd with a great deal of Oil, as the Analyſis teaches us, don't boil at all with the Alkalies;

lies; there are ſeveral other Examples which I ſhall not mention here. 2*dly*, There never was Fermentation without reſt; but how can we find reſt in the Blood when it comes thro' all the Body with a vaſt Rapidity? 3*dly*. It will be objected, how can the *Sal ſalſum* of the Blood be form'd if there is no Fermentation? To this I anſwer, that the acids of Vinegar that diſſolved Lead, will form a *Sal ſalſum* with Alkalies, and yet there is no Fermentation obſerved; beſides, the preſſure of the Heart and Veſſels, the Rarefaction of the contain'd Air in the Blood, will make the Acids enter into the Alkalies, and this will be ſufficient to form a *Sal ſalſum.*

Theſe are Proofs to ſhew that the Parts of the Blood ought not to ferment the one with the other; but we muſt examine ſtill if the Chyle, in mixing with the Blood, ferments not with it; here are a few Obſervations which will make us capable to judge of it. 1*ſt*. The Chyle mixed with acid and alkaline Salts, has no Efferveſcence; if it had ſometimes, it was occaſion'd by the great quantity of theſe Salts, which the Matter that furniſhed the Chyle was fill'd with; then we ſee there may happen a little efferveſcence with the Mixture of the acid and alkaline Salts; but we have obſerved that this efferveſcence is ſcarce perceivable. 2*dly*. When we receive the Chyle into a Veſſel, we obſerve no efferveſcence; nevertheleſs, according to the Gentlemen who are for Fermentation, this ſhould happen when the Chyle is in the Thoracic Duct; for it is then that the Salts begin to act on one another; but it is in vain to examine the Chyle in that Canal with a Microſcope, we obſerve not there the leaſt Motion; theſe two Reaſons prove that the Chyle will not ferment with the Blood, for will it find in the Blood any cauſe of

Fermentation ſtronger than the Acids or Alkalies? But the following is a ſtronger Reaſon: If we tye the Vein through which the Chyle is diſcharged, we obſerve in it no effervеſcence at the time that it mixes with the Blood; after this, the only refuge left to thoſe who maintain Fermentation, is, to ſay that this Fermentation is not ſenſible, *i. e.* we can't prove it by any Experiment, but is a pure Suppoſition which is confuted by the Reaſons we have mention'd, and is not neceſſary to explain the Phenomena in the animal Oeconomy.

But it will be ſaid, Whence proceeds this heat? Is not Fermentation abſolutely neceſſary to produce it? 1*ſt.* What is it they underſtand by the word *Fermentation?* Is it any thing elſe but Motion? Heat, whatever they may ſay, can be nothing but the motion of a Fluid that has a great Spring, or is very much agitated by ſome Cauſe. 2*dly.* We ſee to produce heat, there is nothing neceſſary, *v. g.* but to rub two pieces of Wood againſt one another, for by that rubbing there is nothing but a motion of Vibration in the Parts of the Matter of the Wood, or in a Subſtance very fit for Motion, and is perhaps that which forms the Fire: I ſay, that there may be ſome particular Subſtance which is the matter of the Fire; all oblige us to ſay ſo, we may ſee the Proofs of it in what Mr. *Homberg* ſays on this Head; but not entirely to leave what we advance without Proof, let us make the few following Obſervations. 1*ſt.* We ſee that the Subſtance of the Fire is raiſed from that which burns; we can't conceive of that, if we don't ſuppoſe in thoſe Bodies a Matter that iſſues out as ſoon as it is agitated. 2*dly.* There are Bodies whoſe Parts are very thin, and proper to move, nevertheleſs, we can't heat them by the Motion we give them; hence we ought not to conclude that there is a particular Matter for the fire. *3dly*, The more compact the Bodies are that lie expoſed to the Fire, the more heated they are: Muſt not this proceed from the igneous Matter which enters in theſe compact Bodies, and that are there inſinuated in larger Quantity, as there are more Parts to which it may fix; for there is a greater Quantity of Parts in the compact Bodies than in thoſe that are very thin. *4thly*, How can a Motion continue during all the time there would be Matter to conſume, if there was no fiery Subſtance diſpoſed to fly away as ſoon as we ſhould open the Doors, in breaking the *Capſulæ* that encloſe it?

All which Reaſons being ſuppoſed, we may prove that there is no need of a fermentation to form and keep any heat in the human Body. *1ſt*, The ſolid Parts of the human Body are very proper to be heated by friction. We experience it every Moment by the action of the Hands, or other Parts. *2dly*, As ſoon as the Heart acts by its alternate Motions, it will puſh the ſides of the Arteries, which by their frequent Vibrations will heat by degrees. *3dly*, The Vibrations of the Arteries having very much heated the ſolid Parts, this Heat will be communicated to the Fluids; thus the Solids will be the only cauſe of Heat in a human Body. *4thly*, The fluid Parts which are in the Veſſels, are very liable to heat, ſince they are very oily, and can therefore be heated very much. *5thly*, By what we have ſaid we eaſily ſurmount the Difficulty commonly urged againſt this Opinion, *viz.* how Fluids can heat very much in our Body without a Fermentation, ſince if we beat Water it will never heat; we eaſily find the Reaſon of it in what we have ſaid; if there were nothing but Water in the Body, the Heat would be ſuffocated, but there are other Fluids: Beſides, if the ſides of the Veſſels were very ſtrong, and that Water hindered not the animal Spirit to flow in the Nerves, the Heat might be perceived. If we lay into Water pieces of Wood which heat eaſily, we ſhall ſee that if we rub them a long time the one againſt the other, they will be heated: this cannot be done, but ſome Heat muſt enſue in the Water contained in the Pores. *6thly*, Whatever we juſt now ſaid is confirmed by experience: Let us take a large Frog, open it, and expoſe it to the Cold, we ſhall ſee that the Blood in the Meſentery, will coagulate and be reduced into Lumps; if we put theſe Veſſels near the fire, the Lumps always ſubſiſt, the action of the fiery Particles does not reſolve it; but as ſoon as we preſent the Heart of the Frog to the fire, and that it begins to beat, then all the Lumps diſappear, and Circulation is revived: hence it evidently follows, that it is not Heat which gives fluidity to the Blood, but the Action of the ſolid Parts, which divide it, that its Heat is an effect of the Motion of the Veſſels, and that it is not even abſolutely neceſſary, ſince it is but a continuation of the ſpring of the Fibres; if theſe Fibres might have force enough to divide the Blood; but as they have not enough to be heated, the Blood will by no means be hot, although it be fluid. This is the Caſe in Fiſh. *7thly*, We may by all this ſee, that the Blood which will be too much agitated by the ſolid Parts, will be heated more, and that which will be agitated leſs will thicken. *8thly*, We may explain why the Heat becomes ſtronger when the Circulation finds ſome reſiſtance; the Arteries being more dilated, act with greater force; thus we muſt have a ſtronger perception of Heat.

REMARKS.

The Pericardium or Conic Bag that incloſes the Heart, gave room to many Diſputes; its uſe has not occaſioned a leſs number of Opinions; we ſhall be ſatisfied in mentioning what Experience teaches us, all the reſt is uſeleſs.

It was neceſſary that the Heart ſhould be encloſed in a Bag for many Reaſons. 1*ſt*, The Veſſels ſhould be fixed; for if their ſituation could vary, it would have cauſed a diſorder in the Circulation; for the Pericardium ſhuts them up in their ſituation in ſeparating them from their Ramifications; they are ſo much the better fixed, becauſe the internal Membrane of this Bag is a continuation of Coats of theſe Veſſels. 2*dly*, The Heart ought not to lay floating. This might have produced conſiderable Inconveniences; but we could not have reſolved them in fixing its ſubſtance; its Motions would have been leſs free had it been fixed. To avoid all this, Nature formed a Bag, which is fixed at top at the diviſion of the Veſſels, and below by its adherence to the Diaphragm; we ſee by this, that we cannot ſay the Pericardium ſupports the Heart ſuſpended, it is rather the Diaphragm which is the ſupport of it. 3*dly*, If this Bag was too much ſtraitened, it would have been an hindrance to the Dilatation of the Heart, and its lengthening during the Contraction; it were neceſſary then that the Bag ſhould be of a certain bigneſs; but as drineſs would have cauſed Frictions, which would have been very noxious to the motion of the Heart, it was neceſſary that it ſhould filtrate in the Pericardium a Humour to give it a ſlippery ſurface. *4thly*, This Fluid is commonly ſecreted in a very ſmall Quantity; we cannot doubt but that it flows from the ſides of the Pericardium, ſince we obſerve in the internal Surface an infinite number of Holes, and that by Preſſure we preſs out drops of Water very ſenſibly. *5thly*, In thoſe who die a violent Death, and have the Lungs attacked in ſuch a manner as to hinder the Circulation from being performed freely, we find a great deal of reddiſh Water in the Pericardium; we muſt not think that this Water ſprings from the ſame ſource as the other, but we are to obſerve that the Auricles have a very thin texture; when the Blood cannot be propelled into the Lungs, the Auricles are more ſwelled and more extended than ordinary: it may be then that the Water of the Blood, intermixed with ſome of its Globules, tranſcends through that thin Membrane, and therefore has a red colour. *6thly*, We ſee hence that we cannot ſay, this Water which is commonly found in the Pericardium, comes from the Heart, and is abſorbed by the Pericardium; there is nothing to induce us to think ſo, the drops of Water which flow from the Foramina, and are diſperſed on the internal ſurface of that Bag, prove invincibly to the contrary. *7thly*, There were ſome Authors who looked into the Pericardium for the ſource of the Dropſy, but this is without foundation: We have nothing to conſult but the *Sepulchretum Boneti*, and we ſhall ſee that the common cauſe of a Dropſy is ſome obſtructed Viſcus. Beſides, I don't ſee why we ſhould have recourſe to the Pericardium for the cauſe of a Dropſy:

Do we not find every where Organs equally proper to form this Inundation? Can't the Water overflow as well through the Pores of the Meſentery, Liver, Kidney, *&c.* 8*thly*, There were ſome Authors who denied the exiſtence of a Fluid in the Pericardium during Health, and that Maladies only were the cauſe of it. It is true, that while the Body is in a tranquil ſtate, the Pericardium ought not to receive a large Quantity of Fluid; there is juſt as much as is neceſſary to moiſten the Sides and to render them ſlippery; but this muſt not occaſion ſome to ſay that there is no Water in the Pericardium. 9*thly*, *Peyer* believed that this large Quantity of Water found in certain Subjects, came from the very Pericardium. The reaſon he produces for it is, that he found in Bodies that were very ſick glandular Grains very large and filled with ſerum. This proves that theſe Grains filtrated more Fluid than ordinary; but it is not poſſible for them to afford ſo large a Quantity.

This is what may be ſaid on the ſubject of the Water in the Pericardium, and its uſe: There remains to ſay one word on the different Motions which may happen to this Bag. 1*ſt*, It is agitated continually through the paſſage and exit of the Blood that flows in the Veſſels. 2*dly*, The Diaphragm draws it a little down at each inſpiration, and puſhes it upwards during expiration; hence we ſee that the Veſſels to which this Bag is fixed ſuperiourly, muſt be ſenſible of the effort of the Diaphragm when it is low, and eſpecially when inſpiration is violent.

REMARKS.

The Cavity of the Mouth is terminated by a ſecond Cavity, whoſe entry is an Arch, in the middle of which hangs a kind of fleſhy Cone, which is the Palate; under this Arch we find immediately a ſmall deſcent at the root of the Tongue, then we ſee the Epiglottis, which is as a kind of Bridge that is thrown on the Arytenoide Cartilages to ſhut the Groove of the Glottis or Entry of the Larynx: Next we ſee the Orifice of the Œſophagus, whoſe poſterior and lateral Sides are ſuſpended at the inferior part of the Cranium, anteriourly they are fixed to the Larynx and Os Hyoides, and to the ſides of the Palate: Theſe Sides are Muſcles which we ſhall deſcribe in ſpeaking of their action; here is the beginning of the Œſophagus, which is that membranous Duct compoſed of the Membranes we ſee in *Heiſter*'s Table; it goes to the left ſide of the Spine of the Back the length of the left and poſterior part of the Trachea: The Aorta makes it turn back a little to the right when it enters in the Thorax, then it is thrown a little on it; at laſt this Canal terminates at the Stomach, juſt as we have heretofore ſaid.

The uſe of this Duct is known by every Body, but the Mechaniſm of its Motions is not as yet cleared. If it be aſked, why the Aliments deſcend immediately into the Stomach? We anſwer, That their weight carries them towards the Stomach; but when we lie down, don't they in the ſame manner deſcend without the help of the Weight? Beſides, are there not Perſons who eat and drink, their Bodies being placed perpendicular to their Head? If nothing but the Weight cauſed this Deſcent of Aliments in the Stomach, it would then produce a quite contrary effect.

Other Philoſophers had recourſe to the Periſtaltick motion of the Œſophagus to conduct the Aliments into the Stomach ; but this Motion is not ſupported by any Proofs. And even if it were, would it not be performed from a top to bottom and bottom to top? Thus it would hinder Deglutition as much as it would favour it : beſides, a lateral Motion can no more contribute to the Deſcent than Aſcent of the Aliments ; for is not the Periſtaltick Motion lateral? Let us ſee then what may be the cauſe of the Aliments Deſcent.

The firſt thing we muſt look after, is, why the Aliments enter into the ſecond Cavity that terminates at the Mouth? Becauſe the Tongue raiſes and throws itſelf on the Pharynx. This Motion proceeds from many Organs. 1*ſt*, Muſcles that form the Body of the Tongue, and which apply its Point to the Roof of the Palate, and its Sides to the Root of the ſuperiour *Dentes Molares*, ſo that every thing that is on its Back may be precipitated entirely under the Larynx. 2*dly*, The Muſculi Sternohyoidei that riſe from the internal part of the Clavicle and Sternum by broad fleſhy and Heads, and are inſerted at the Baſis of the anterior Os Hyoides. Theſe Muſcles, I ſay, draw the Root of the Tongue down. 3*dly*, The Muſculi Coracohyoide, which riſe by round and fleſhy Heads from the Root of the Coracoide Apophyſis, draw the Tongue back. 4*thly*, From the oppoſite forces of theſe two pair of Muſcles there reſults a leſs impulſe that turns the Tongue on the Larynx.

The Aliments being conducted on the Larynx, there remains to ſeek, 1*ſt*, For a Cauſe which ſtrongly puſhes them into the Pharynx. 2*dly*, A Force or an Obſtacle that hinders them during this preſſure, from running through the Noſtrils ; for we muſt not doubt but they would go out that way, if the Ducts were open, as they do ſometimes.

The Force that propels the Aliments into the Pharynx, ariſes, 1*ſt*, from the Tongue, which then is drawn backwards and upwards by the Muſculus Stylohoideus, which riſes with fleſhy beginning from the Stoyloide Apophyſis, is ſtopt in its way by the Digaſtrick Muſcle, and is inſerted at the Baſis of the Os Hyoides, at its articulation with the Horn. This then is alſo a Force that puſhes the Aliments backwards. 2*dly*, While this Muſcle acts, the Muſculus Thyroideus extends alſo; as it ariſes from the ſide of the Os Hyoides by a fleſhy beginning, and fixes at the lateral and inferior part of the Tyroide Cartilage, it ſhould by its action raiſe the Pharynx, then the Os Hyoides is applied to the Cover of the Palate, and conſequently puſhes backwards the Aliments; for the Space that they occupied anteriorly diminiſhes by the Preſſures juſt now mentioned. According to this Mechaniſm we ſee there is no fear of the Aliments returning through the Noſe, for the Os Hyoides puſhes the Cover of the Palate up, beſides two of the Muſculi Pterigoſtaphilini raiſe the Palate, covering it by their contraction.

After having propelled the Aliments to the Pharynx, it is neceſſary at the ſame time to open that Bag to let them enter, for which we muſt find a Force that may draw it ſideways and forward; the Muſculi Stylopharingii that are inſerted at the Sides, avoid by their action the lateral Side. The Muſculi Genioglоſſi, Mylogloſi, Geniohoidei, draw upwards and forwards the Root of the Tongue, they muſt conſequently draw forward the Larynx, and ſeparate the anterior ſide of the

Pharynx from the Poſterior: The Cephalopharingian Muſcles ſhould ſtill by their action encreaſe the Pharynx; the external Pterigoidean Muſcles, which ariſe from the external Side of the external Wing of the Pterigoide Apophyſes, and are inſerted at the internal part of the inferior Jaw-bone between the Coronoide and Condiloide Apophyſis, draw the inferior Jaw-bone upwards and forwards, and produce conſequently the ſame effects as the precedent; all theſe Muſcles by their contraction ſhould conſiderably widen the Pharynx.

All theſe Muſcles being thus extended, we ſee eaſily that it is impoſſible but the Aliments muſt be carried down into the Pharynx, eſpecially the Œſophagian Muſcle, which acts as a relaxed Sphincter; for the Tongue being repelled towards the poſterior Sides of the Pharynx, and the Larynx being carried againſt the Roof which is on the Orifice, it is evident that all that is on the Larynx muſt be there ſunk in the Œſophagus.

When the Aliments have ſunk, the moſt part of the Muſcles we have mentioned diſband, the Action ſubſiſts only in the Coracohyoidean Muſcles, and in the Sternohyoidean; hence the Aliments are preſſed and puſhed down in the ſame time the Œſophagian Muſcle acts, its contraction joined with the Muſcles of which we have been ſpeaking, precipitates the Aliments into the Breaſt.

But when the Aliments are come into the Breaſt, what makes them continue their way to the Stomach? 1*ſt*, All the Muſcle that forms the ſecond Coat of the Œſophagus contracts. 2*dly*, The ſuperiour Part is immediately cloſed by the Mechaniſm we have obſerved. 3*dly*, The Œſophagian Muſcle, which is very ſtrong, ſtraitens the upper Part of the Œſophagus with more force than the muſcular Coat ſhuts the Middle or the Extremity. *4thly*, It is evident that the Aliments ought to be carried towards the part where they find leſs reſiſtance; but the inferior part of the Œſophagus and Stomach reſiſt leſs, as we have proved, the Aliments muſt therefore neceſſarily deſcend; there happens the ſame thing here as in a filled Inteſtine; if we preſs it with two hands placing the one after the other, and that we ſqueeze with the one more than with the other, it is plain that whatſoever is in that Inteſtine muſt come out with rapidity through the Place leſs preſſed.

This Force alone may explain Deglutition; but we don't conceive well how it can be great enough to make a full Stomach contain two or three Bottles of Wine, the Body being placed perpendicularly to the Head. What we can ſay in anſwer is, that the Velocity of the Aliments is very great in the Œſophagus, which is very ſtrait, and they deſcend very ſlowly into the Stomach, becauſe it is very wide: Thus a very ſmall Force will ſuffice to afford place in the Stomach for the Aliments there.

But to this Reaſon we muſt add another, as the following. The Lungs muſt neceſſarily preſs by their expanſion the Œſophagus that runs at the left Side the whole length of the Spine, beſides the Aorta by its Pulſations muſt ſtraiten it; we cannot doubt but theſe two Preſſures contribute very much to the deſcent of the Aliments in the Stomach: but we muſt remember that we ſhould always ſuppoſe the ſuperior Orifice of the Œſophagus ſhut, for the Preſſure of the Lungs and Aorta would contribute as much to occaſion the Aliments aſcent as well as deſcent. This is evident, ſince its Organs preſs the Œſophagus only laterally, but the ſuperiour Part of that Duct being ſhut, the Aliments may be puſhed down with facility by the Action of the Aorta and Lungs. This, I believe, is what may be ſaid on Deglutition. Let us explain ſome Phænomena that attend it.

1*ſt*, If the Gullet is very dry, Deglutition is very difficult: The reaſon of this is plain; in order that the Aliments may flow, there ought to be in the Gullet a Fluid to render the Membranes ſlippery. If this Fluid is wanting, the Gullet will be dry and rough. Thus the Aliments will be ſtopt. 2*dly*, When the Uvula is wanting, we cough in drinking. To explain this, an Author ſays, that when the Stylogloſſian and Tyrohoidean Muſcles act, the Cover of the Uvula is applied to the openings of the Noſtrils, the Epiglottis is preſſed on the Glottis, the Uvula which is lowered by theſe Muſcles is applied to the Groove of the Glottis, which thereby is ſhut much better; but when the Uvula is wanting, the Glottis, which is not ſhut, receives ſome drops of what we drink; the Liquor that enters into the Trachea, irritates the Texture of the Duct, and cauſes a Cough. 3*dly*, When the cover of the Uvula is cut, the Aliments go out through the Noſe, becauſe the Ducts of the Noſe not being able to be ſhut exactly, the Aliments preſſed by the Tongue and the Larynx find it more eaſy to return through the Noſe than to enter in the Œſophagus. 4*thly*, In the Quinſy the Symptoms muſt vary according to the various Muſcles enflamed; if the Muſcles that ſerve to raiſe the Os Hyoides, to turn the Tongue, and raiſe the Larynx, are attacked, the firſt Motions of Deglutition are very painful: If the Pharynx only is enflamed, Deglutition is impoſſible, becauſe the Muſcles being enflamed they can't contract without great pain; then the Aliments return through the Noſe. If the Almonds of the Throat, the Uvula, the four Pterigoſtaphilin Muſcles, are the Seat of the Inflammation, we ſhall not be able to reſpire through the Noſe; the Aliments return through the Mouth becauſe of the terrible Pains they cauſe in entring under the Arch. *5thly*, There are Caſes where we may ſwallow Fluids; but where it is impoſſible to ſwallow Solids. This is when the firſt Organs of Deglutition are enflamed. As the Solids reſiſt, it is neceſſary that the Muſcles that run over the Tongue attempt to precipitate theſe things; but this Effort can't be performed becauſe of the Inflammation of the Organs that ought to act; but the Fluids make no reſiſtance, they flow ſpontaneouſly on the Pharynx, ſcarce is it neceſſary that the Tongue have any Motion; we ſhall then be able to ſwallow Fluids, and not Solids. *6thly*, There are Caſes where, to the contrary, we can ſwallow Solids but no Fluids. Nothing can be the cauſe of that but an Inflammation of the Cephalopharyngian Muſcles; for when we ſwallow Fluids, theſe Muſcles muſt open of themſelves to let them enter; but if they are enflamed, they can't contract, nor act conſequently without pain; but when we ſwallow Solids, the Tongue turned propels them, and makes them enter the Pharynx, without any need almoſt of the contraction of the Cephalopharyngian Muſcles; but this Preſſure, cauſed by the Action of the Tongue, is leſs painful than the contraction of theſe Muſcles.

7thly, There are long Maladies that are followed with an impoſſibility of ſwallowing. This happens, eſpecially if theſe ſickneſſes were attended by large Evacuations; ſuch a Symptom has no other Cauſe but a Paralyſis of the Organs of Deglutition, and leaves but little hope to the Patients, ſince it is always a ſign of Death. There happens ſtill a like Paralyſis, when the Nerves that are diſtributed in the Pharynx ſuffer any Compreſſion. Some Authors ſay, they obſerved ſuch a Paralyſis in the Luxation of the Vertebræ of the Neck.

Hunger & Thirst

In ſpeaking of the Stomach we have ſaid nothing of Hunger nor Thirſt; we are now to ſee the Cauſe of theſe. The Ancients ſaid, that the Veins ſucked the ſubſtance that was in the Stomach; and this ſucking was the cauſe of our perception of Hunger.

Almoſt all the modern Phyſicians ſaid that the Senſation we perceive, when we have been long without eating, ariſes from the Action of the Fluids which were filtrated in the Stomach; their Salts in acting on the Membranes cauſe theſe Senſations, according to their Opinion, which ceaſe not but when we take Nouriſhment which partakes with the Stomach of the Action of the Fluids.

We muſt not doubt but the Saliva and Stomachical Juice can cauſe ſome Senſation; we prove it every Moment in ſwallowing our Spittle, ſince we then perceive an agreeable trickling, if we are in health; beſides, we know by the Analyſis that the Saliva encloſes Salts which are capable of making ſome Impreſſion. Beſides, this Opinion ſeems to be confirmed by experience, which teaches us that as ſoon as the Saliva is vitiated the Appetite ceaſes entirely.

The Juice that ſtimulates the Stomach, was ranged among the Acids; we have ſeen that Vinegar excited Appetite the ſame as other like Liquors; and it is on theſe Effects, and on ſome pretended Analyſis, that we have founded the Acidity of the Juice which cauſes Hunger.

We can't deny that the Saliva and Stomachical Juice does not contribute by their Action to the perception of Hunger; but I can't be perſuaded that theſe Fluids are the only and principal Inſtrument: the more we faſt, the greater Quantity of Stomachical Juice is filtrated, nevertheleſs Appetite is not augmented in proportion; we obſerve it diminiſhes, when we have been a long time without taking any Nouriſhment: nevertheleſs the Stomachical Juice becomes then more ſalty, and conſequently more proper to ſtimulate the Membranes. Thoſe who think the Stomachical Juice is the only cauſe of Hunger ſeem to have as little a foundation for it as thoſe who would ſuſtain that the Perception we feel at the Parts of Generation, ariſes from the Fluid that filtrates and ſtimulates the Membranes there.

We can't doubt but the Paſſion which occaſions Venery proceeds from the Blood gathered in the genital Parts. This Blood in ſwelling the Veſſels cauſes there a beginning of an Inflammation, and it is in the Impreſſion which cauſes this beginning of an Inflammation, that the Pleaſure perceived conſiſts when we have been ſtruck with ſome lovely Object. Let us ſee if Hunger can't be explained in the ſame manner.

The Stomach is a Bag that is extended, when it contains the Aliments, and flaccid when empty: We cannot doubt but that the Blood flows with more facility in the Membranes of that Bag when they are extended than when flaccid; for in the extended Fibres the Blood flows without being obliged to paſs through many Pleats; for when the Stomach is flaccid, the Blood can't have a free Courſe becauſe of the diverſe Pleats made by the Membranes; thus it muſt ſwell the Veſſels. This ſwelling can't proceed without the beginning of an Inflammation; for a Part enflames not but by Obſtructions, which produce ſwellings in ſtopping the Blood. This Inflammation beginning muſt ſtimulate the Nerves, and produce an itching, which ceaſes as ſoon as we renew this courſe to the Blood by extending the Veſſels, for this Tenſion in placing them in Right Lines, gives the Blood the liberty of its Courſe.

This mechanick explication perfectly anſwers all the Phænomena, and ſuppoſes nothing which is not proved. 1*ſt*, The beginning of an Inflammation cauſes a Titillation; for the itching on the Skin, or any where elſe, are cauſed by nothing but the Blood's being ſtopped, that ſtrongly puſhes the nervous Fibres, and conſequently extends them; this Tenſion cauſes an agreeable perception, when it is not ſtrong; but it is painful, when violent; becauſe then the nervous Fibres ſeparate and break. 2*dly*, When we have been long without eating, we find the Appetite vaniſhes, becauſe the Stomach having Veſſels very much ſwelled has almoſt no more perception; for the Veſſels preſs then the Nerves with force; but the Nerves ſtrongly compreſſed have no more perception. 3*dly*, When the ſides of the Stomach are covered with a thick Saliva, we perceive no Hunger, becauſe the Blood has a thick Lymph, and is violently propelled by the ſolid Parts; in the Fluid that is filtrated, the aqueous Part is loſt immediately by the Heat cauſed by the agitation of the ſolid Parts, there remains then but a thick Matter that muſt ſtop at the ſides of the Stomach; but it is certain that the thickneſs of the Blood and Heat ſhould produce an Obſtruction in the Stomach; this Obſtruction having too much ſwelled the Veſſels, they cauſe a Compreſſion in the Nerves which deſtroys their perception. *4thly*, At the beginning of certain Maladies, in the Pleuriſy, for example, we perceive a great Appetite, becauſe *1ſt*, By the communication of the Nerves of the Stomach with thoſe of the Pleura. *2dly*, The Blood being ſtopt in the Intercoſtal Arteries, runs in a greater quantity in the Cæliac. *3dly*, The Pleuriſy happens ſometimes by ſome gathering ſuddenly made in the Membranes of the Stomach, as when we drink a Liquor extremely cold whilſt we ſweat much. All this muſt ſwell the Veſſels of the Stomach, and cauſe there the irritation we have mentioned. *4thly*, In acute Diſeaſes we have no Appetite, becauſe theſe Maladies are cauſed by the Inflammation of ſome of the Viſcera; but by that Inflammation the Nerves of the Stomach are drawn by their communication with the enflamed Viſcera; beſides, the Blood not being able to circulate freely in theſe Viſcera, is thrown in a greater quantity into the Arteries of the Stomach; hence follows a Compreſſion in the Nerves, and a want of feeling. *5thly*, If the Membranes of the Stomach were very much relaxed, the Nerves would be ſo too, there would therefore be no perception, and conſequently Appetite; hence it is when there is too much Saliva or ſtomachical Juice filtrated, we feel no more hunger. *6thly*, If the Bile be expanded in the Ventricle in too great a quantity, the diſagreeable Senſation that it will cauſe at the Mouth, will cauſe a loathing of Food, becauſe the Bile mixing with their Subſtance gives them a diſagreeable taſte. *7thly*, There are Matters that can give Appetite, ſuch are thoſe that are bitter or acid; they ſtimulate the nervous Papillæ of the Stomach, and ſtraiten the Veſſels; thus the Blood muſt flow there with greater Force. *8thly*, In emptying the Veſſels, and in rendring the Blood fluid, we may re-eſtabliſh the Appetite, ſince we diminiſh by that the Compreſſion of the Nerves of the Stomach. *9thly*, Appetite is ſharper in Winter than in Summer, becauſe the Blood fills the Veſſels more, and gives greater Force to the muſcular Membranes of the Stomach; but in Summer the evaporation by Heat renders all the Parts flaccid.

That which cauſes Hunger, ſays *Bergerus*, is cauſe of Thirſt; but that is not true; the perception of Hunger is not always accompanied with Thirſt; and we feel a great burning in our Entrails at the ſame time we are moſt filled with Nouriſhment: The cauſe of Thirſt is nothing elſe but the Heat excited in the Stomach by divers Cauſes. *Firſt*, If the Gullet is not moiſtened, Thirſt is perceived, becauſe the Veſſels being dry ſtraiten, and by that augment the Motion of the Blood; it is thus, that in phthyſical People the Palm of the Hand is very hot after Meals. *2dly*, If there are glutinous Matters in the Stomach, Thirſt may follow, becauſe, as we have obſerved before, theſe Fluids which have Viſcoſity, are an effect of Heat, and that they ſuppoſe always a Blood deprived of its Lymph; when the Blood has no more aqueous Humours, it is thick, it can't paſs freely through the capillary Veſſels; it ſwells then the Arteries, which muſt therefore beat more frequently and ſtrongly, which could not be if the Heat did not augment. *3dly*, The Salts, ſharp Subſtances or Bodies that contain much fire, muſt cauſe Thirſt; for all theſe Subſtances put in motion the Solids, and there conſequently excite heat. *4thly*, In Fevers a violent Thirſt is perceived; the Reaſon is not difficult to be found; Fevers are not cauſed but by the Obſtructions, the Arteries being ſtop'd ſwell; they muſt then therefore beat more ſtrongly and frequently, and hence more heat follows. *5thly*, In Dropſies we perceive a violent Thirſt, becauſe the aqueous Part of the Blood remains in the Abdomen, there will then be but a thick Blood in the other Parts; this thickneſs will neceſſarily cauſe Heat: beſides, the Abdomen being filled with Water, the inferior ſanguinary Veſſels are very much compreſſed, the Blood flows then in a great Quantity towards the ſuperior Parts; hence it follows, that the Motion and Heat are there more conſiderable, and that Hemorrhages often happen in Dropſies. *6thly*, Hence we ſee that it is a bad Sign, as *Hippocrates* ſays, not to be thirſty in acute Maladies; this ſhews that the Organs become inſenſible, and that Death is not far off.

REMARKS *on the Neck.*

We are told by ſome Travellers, that there are People in *America* who have no Neck; the Head, ſay thoſe Authors, is placed immediately on the Breaſt; but that is but an idle Story; it is poſſible thoſe Gentlemen ſaw Men whoſe Shoulders were extremely raiſed; I have really been told by ſome Travellers, that they had ſeen People of that kind.

The Neck is a Part, the neceſſity of which appears very obvious; we have need of moving our Heads in divers Senſes; theſe Motions would be almoſt impoſſible without the Neck: It is to facilitate theſe Motions that the Neck is of a middling ſize, if its Diameter had been equal to that of the Cranium, the Head could not commodiouſly have inclined forwards, and the Inferior Jawbone would have found an hindrance, were it to be drawn by the Digaſtrick Muſcle.

We obſerve that thoſe who are ſhort-necked are ſubject to Apoplexies, becauſe in the proportion that the Neck diminiſhes in length, the whole Breaſt augments, and conſequently the Maſs of the Lungs; but when the Maſs of the Lungs is too conſiderable, there are there formed Plethoræ with greater facility: Theſe Plethoræ interrupt the Circulation in the Head and other Parts, ſince the Blood that comes to the Heart can paſs no more to the Lungs. There is a celebrated Phyſician who believes that even the Epilepſy often proceeds from nothing but ſuch a little Plethora; and hence it comes (ſays he) that they keep their Hands always on the Breaſt.

There is one thing which we muſt give attention to, and that may contribute to an Apoplexy, which is, that when the Neck is too ſhort the leaſt Motion is very conſiderable in each Vertebra; thus the vertebral Arteries are compreſſed more eaſily; but when the Neck is very long, the Motion divides in more pieces; thus the Motion is leſs at every Vertebra.

If the too ſhort Neck is ſubject to Inconveniencies, the too long Neck is no leſs ſo; we ſee that this length is always a prediction of a Phthiſick; the reaſon of it is eaſily found; the length of the Neck diminiſhes the Cavity of the Breaſt; thus the Blood that circulates then more difficultly in the pulmonary Texture, forms more eaſily the Tubercles which are formed in the Lungs, and which give riſe to a Conſumption, as *Morton* obſerved.

This is not the only Inconvenience thoſe who are long Necked are ſubject to. This length may occaſion an Aſthma; for, as M. *Michelotti* ſhews us, when the Trachea Arteria is too ſtrait, the Air can't iſſue out but with great difficulty. We find a Proof of this in an Angina; but the length of the Trachea Arteria produces the ſame Inconvenience as the want of it; it is at the ſame time narrow, as we may ſee in Diſſections.

REMARKS *on the Head.*

The oſſeous Box that encloſes the Brain, is covered by ſeveral Teguments; the firſt are the Epidermis and Skin; from the Organs found in theſe two Membranes runs continually an oily Matter, which gives the external Surface of the Head that moiſture and pliantneſs it ſtands in need of; it alſo defends the internal Parts from the Injuries of the Air, in the ſame manner as the Oil filtrated in the Scales of Fiſh defend them from the Injuries of the Water; hence the Impreſſions of Cold become leſs ſenſible, and the Parts of the Water that are not joined with the Oil can't be inſinuated into the

Head; this is not the only advantage that accrues from this oily Subſtance, the Hairs find a Nouriſhment by it that hinders them from drying, growing briſtly, friſling; that which is ſuperfluous evaporates, and the moſt ſubtil Parts having eſcaped leave a groſſer Matter, which is in the form of Bran, and forms that which we call the *Dandriff.*

There are Authors who believed this *Dandriff* was nothing but the ſcaly Extremities which compoſe the Epidermis, and that we tear off, according to them, when we comb ourſelves; but the great Quantity of Oil we may preſs out of them, and which enflames eaſily, ſhews that it can't be a part of a very dry Membrane: Beſides, how would it be poſſible that we ſhould tear off ſo great a Quantity of *Dandriff* of the Epidermis only? That Oil which filtrates in the Teguments of the Head, ſhews us why the Matter of the Sweat is thicker in that Part than in others; as there is there conſtantly depoſited ſome Oil, the Water preſſed out of it during Sweat muſt neceſſarily diſcharge that Fluid. We find alſo in that Oil the reaſon why the Head ſtinks, when it is covered a long time; there then is filtrated a great Quantity of Oil which heats; by that heat the volatile Parts ſeparate, and ſtrike diſagreeably the Smell; during this time the Hats muſt take a yellow tinge; the heated Oils give all this Colour.

The Head is the principal of all the Action of the Body; for which reaſon Nature covered it with Hairs to defend it againſt the Injuries of Time; this Defence falls with Age; the Coats that dry permit not the nouriſhing Juice to filtrate any more. Thus the Hairs muſt grow white, and fall at laſt without growing again.

After the common Teguments, come the frontal and occipital Muſcles, which we ought to look on as contrary and conſpiring forces, at the ſame time their Action is contrary, ſince the one draws backwards and the other forwards; nevertheleſs their Motions are conſpiring; for when the frontal Muſcles raiſe the Eye-lids, the occipital Muſcles by their Contraction ſerve as a Support to the Muſcles of the Forehead; thus they concur in the ſame Action.

We at laſt diſcover the Pericranium. Some have pretended that there was beſide this a Perioſteum, but it is without reaſon; it is true, that the Pericranium is a Perioſteum, but we muſt not make two Membranes of it. We have in another place juſt touched upon the uſe of the Perioſteum, but we muſt ſpeak a little more of it here. There were Authors who advanced that it hindered the Bones growing too much: but can we ſuppoſe that ſuch a ſmall Membrane ſhould be an obſtacle to the Efforts made by a Matter ſo extremely hard? Beſides, what uſe would the Internal Perioſteum be of, according to this Idea? We can't ſay that it hinders the Bones from extending in the Space that forms their Cavity; we can neither ſay this of the external Perioſteum, ſince it has no different uſe from that of the Internal Perioſteum; we have not advanced with more Foundation that it ſerved to propel the Blood in the bony Subſtance during the Dilatation of the Heart. A particular Author imagined, that when the Heart is relaxed, we ſhould ſubſtitute for it a Force that might preſs the expanded Blood in the Veſſels which are between the Bone and the Perioſteum. This Membrane appeared very proper for that uſe, ſince the Heart in contracting, and in filling the Veſſels that creep on the Bone, raiſes it. This ſupported Membrane is re-eſtabliſhed in its firſt ſtate by its Spring, and neceſſarily compreſſes the Veſſels that come from the Bone; this Compreſſion propels the Blood into the bony Subſtance, when the Action of the Heart ceaſes. To give ſuch an Explication we do not obſerve the Veſſels and different Poſitions of the Perioſteum. 1*ſt*, In the time that the Heart relaxes, the Arteries act on the Blood with the ſame force as the Heart, for the Re-action is equal to the Action; we muſt not therefore ſeek in the Perioſteum for an Action which ſupplies that of a relaxed Heart. 2*dly*, In the Grooves the Perioſteum is diſpoſed in ſuch a manner, that its Spring obliges it ſooner to be diſtant from the Bone than to approach it; nevertheleſs it has in thoſe Grooves the ſame uſes as on the convex Surfaces. 3*dly*, We can't ſay that the internal Perioſteum may produce this effect; we muſt not therefore ſay that the external Perioſteum was placed on the ſurface of the Bone as a Spring lightened which preſſes the Blood continually in the bony ſubſtance; the following is a more likely explication on the uſe of the Perioſteum. As the Bones ſend forth and receive Veſſels in all the extent of their Surface, it was neceſſary to give theſe Ducts a ſupport; for if they crept alone on the bony Surface, the rubbing of the neighbouring Parts would have diſordered them: when this Membrane is looſened, Exoſtoſes happen, *i. e.* Tumours are formed in the Bone; the reaſon is ſoon found, after what we have ſaid. The Veſſels being taken away with the Perioſteum, can't receive more Blood, nor tranſmit more; the Surface of the Bone whoſe

Fibres were ſeparated by an infinite Number of Veſſels, dry, ſince they recieve no more arterial Blood from the Perioſteum for its Nouriſhment; by this drineſs the Interſtices of the Fibres through which the Veſſels paſſed, approach one another; on another ſide the Orifices of the Veins that end at the Perioſteum, are choaked by the drineſs of the ſurface of the Bone; thus the Blood is heaped always under that Surface; this accumulation occaſions this Surface to be raiſed into a Tumour, and the Bone at laſt begins to exfoliate; we ſee hence, that if the Perioſteum borders the Bones, as we have ſaid, it is by this Accident only, and not by the force of its Spring.

In the ſame manner as the Epidermis is renewed, the Perioſteum alſo appears again with its bony Subſtance, which repairs that which had been ſeparated by the exfoliation; this renewing of the Perioſteum is very difficult to be explained: As we can give but very weak Conjectures thereon, we ſhall not remain long on it. Some ſaid that there is no appearance, that the Ends ſeparated from the Perioſteum, extend to rejoin, but that it forms rather a Membrane on the renewed Bone, and that this Membrane joins with the Ends of the Perioſteum.

Contuſions that happen to the Pericranium, are very dangerous, although they be in themſelves ſlight. This proceeds, 1*ſt*, From the great ſenſibility of the Pericranium, the which proceeds from the numerous Ramifications of Nerves expanded there, and that always cauſe great Miſchief, when the continuity of their Canals are interrupted, as we ſhall explain hereafter. 2*dly*, Contuſions which ſtop the Courſe of the Fluids in the Pericranium in cruſhing the Veſſels, accumulate very much Blood in the Arteries; this accumulated Blood cauſes a conſiderable Inflammation, in the Pericranium. *3dly*, The nearneſs of the Muſcles makes the Wounds of the Pericranium very dangerous alſo; for by the Compreſſion of the Nerves, and by the Inflammation which enſues, they enter into Convulſion. *4thly*, The nearneſs of theſe Sutures contribute ſtill to the dangerous Conſequences of Contuſions of the Pericranium, becauſe it is by the Sutures that the Dura Mater communicates with the external Parts of the Head. *5thly*, When in Wounds of the Cranium there follows ſome time after an Ophthalmy, the Wound muſt be looked on as mortal; it is the Pericranium which is the foundation of that, for then it ſuffers an extraordinary Inflammation which extends to the Eyes.

REMARKS *on the Action of the ſolid Parts.*

There are but two Membranes which ſurround the Brain, the Arachnoides is not a third Membrane different from the Pia Mater, we can no where ſeparate it; as ſoon as we have opened the Cranium, we find a Membrane that inveſts the Brain, and communicates with the external Parts by Sutures, and forms Sheaths for the Nerves through all the extent of the Body: in the middle of the Brain ſuperiorly it ſinks and allongates to a certain deepneſs; this allongation which divides the Brain into two, is called the middle becauſe of its figure; under the two poſterior Lobes this Membrane allongates forwards, and forms a Tent to bear up theſe Lobes, and ſerves as a ſupport to the middle; from the middle of that Tent, there is an allongation ſtill more inferior that divides the Cerebellum; as for the Pia Mater it embraces firmly the Cerebrum, follows all the Pleats in the which it ſinks, and carries the Veſſels every where; we will not ſtop any longer to deſcribe the Membranes, we will only examine the Opinion of *Baglivi*, who attributes a Motion as that of the Heart to the Dura Mater; we will at the ſame time examine his Opinion on the Action of the Solids that flow from the ſame principles, for which reaſon we will give an exact Account of his Book, entitled *De Fibra Motrice*, and we ſhall afterwards ſee what we ought to think thereon.

The Heart ſeems to have an extraordinary Force, but it yields very much to that of the Brain; this we may prove by Wounds of the Head, which produce a Pain through all the animal Œconomy; theſe two Powers have under their command two different Parts; this may be demonſtrated by the voluntary Motions produced in the Members, without altering the Motion of the Heart; by the different Nouriſhment of the membranous and fleſhy Parts, by the Maladies of the nervous Parts that always give Pain to the Head, without troubling the functions of the Heart; by the Blows that ſtrike the Head, and produce Headachs and Tumours, while the Heart is in its natural ſituation; by the different Remedies applied to theſe two kind of Parts; the Meninges form three Rows of Fibres, and produce the Motions of the membranous Fibres; the Dura Mater has for that a Motion of Syſtole and Diaſtole, the ſame as the Heart; this is proved by the alternative Motions that we obſerve in the Brain of new-born Children, by the Wounds of the Head, where the Dura Mater being diſcovered beats equally all over by the extraordinary Pulſation which moves the Dura Mater during the Convulſions, by the Agitations that follow on all the right ſide, if we pitch the Dura Mater on that ſide. All theſe Reaſons ſhew that the Dura Mater is not only deſtined to cover the Brain, but that it is a ſecond Heart; the Heart adheres to the Mediaſtinum, the Dura Mater to the Cranium, and goes through the Sutures to form the Pericranium; its Motions are perceived at the ſame time as the Pulſations of the Heart; but it owes not its Motions to the Arteries that creep on the Surface; for three little Ramifications on each Side can't produce ſuch violent Pulſations; in the ſame manner as that Muſcle, receives the Blood which comes from all the Body, the Dura Mater gathers in the Sinus the Blood that returns from all the Parts of the Head. This force of the Dura Mater ariſes not, according to *Baglivi*, from the Nerves; according to his Opinion (which nevertheleſs is erroneous) there has not been obſerved in that Membrane any nervous Filaments; it is only, ſays he, the Columns that fix the Dura Mater, and the Texture of that Membrane which perpetuates the Motion in all the Body from top to bottom; by theſe Oſcillations the Dura Mater may ſend a Fluid to nouriſh the membranous Parts, and then preſerve the Spring; this Motion tranſmitted to the inferior Parts, reflects back continually; if this Reflexion is troubled, all the animal Machine is troubled; hence it is that an Epilepſy begins ſometimes at the Feet and other times at the Head. To ſhew that the Motion of the Meninges propels the nervous Juice, we are but to conſider that the force of the Heart being parted into an infinite Number of Veſſels, it can't propel the nervous Juice; it is therefore the Meninges only that can produce this effect; their force is alſo ſuperior to the force of the Heart, for in the Pains of the Head the Pulſe becomes almoſt inſenſible; in the Pleuriſy it is very ſmall at the affected Side; in the cold Fit of a Fever it concentrates; but Diſeaſes of the Heart paſs not in like manner to the Head; it is neceſſary then that the Meninges carry it above it, by their force; it is this force that occaſions an infinite number of Diſtempers; when the Oſcillation of the Meninges is violent, every thing is inverted in the Body, witneſs the Epilepſy in which the Effort of theſe Membranes produces the redneſs of the Face; the Froth, Convulſions, Pulſations we feel at the Head, which is falſly attributed to the Arteries; in Maniacs theſe Membranes are found extremely ſtrong and ſtiff, hence ariſes the immenſe Force that all the Parts have in this Malady; but if the Action of the Meninges troubles the Body, when it is too violent, their Inaction there cauſes the languiſhing and ceſſation of all Motion; in Apoplecticks alſo the Meninges are often found adhering to the Cranium: ſince theſe Membranes cauſe ſo much diſorder, we cannot be ſurprized if the other Membranes which are a continuation of it, are ſubject to very acute Maladies; and if the Pains that we perceive in the Bones are a prediction of Convulſions, for then the Perioſteum is attacked, and their Action is communicated to the Meninges becauſe of its continuity.

The force of the Solids of which we have been ſpeaking, muſt be balanced by the force of the Fluids, *i. e.* that the Forces of the Dura Mater muſt be balanced by the Forces of the Heart; for let us ſuppoſe that the Blood be propelled by the Heart with greater Force than it is by the Dura Mater, it will ſtop, will produce Catarrhs, will run with an unequal Velocity in diverſe Parts; hence it will cauſe Convulſions; this happens to thoſe who have little Heads, for then the Dura Mater has not force enough to repel the Blood that comes from the Heart; but if the Meninges act with too much violence, the Blood will be propelled with more force by their Action than by that of the Heart; thoſe in whom this happens, have a great deal of Vivacity, ſleep with great difficulty, are ſubject to a thouſand varieties of Pulſes; in acute Maladies, Watchings, Inquietudes, weigh them down immediately; then the Delirium follows eaſily, becauſe the Meninges enflame; by this inflammation the Brain is ſo ſtrongly compreſſed, that they fall into a Lethargy: although there is often an Equilibrium between the force of the Blood and that of the Meninges, the force of the fleſhy Parts conſidered in itſelf is leſs than that of the Meninges, for when we have drawn a great Quantity of Blood, Convulſions follow, becauſe then the fleſhy Parts deprived of the Maſs of the Blood by which they counterbalanced the Meninges, are obliged then to yield and follow their Action; by the ſame Reaſon tender Conſtitutions are very eaſily agitated, and are ſubject to Convulſions in Fevers; the convulſive Motions which follow the immoderate uſe of Venery, and violent Exerciſes, are occaſioned by the ſame Cauſe; to this we muſt refer the Pains of the Head that degenerate into Tremors or Convulſions; ſo that in this defect of Equilibrium it is that we ſhall find the ſource of an infinite Number of other Maladies and Phenomena that embarraſs ſo much in practice. The irritation of the Parts, for example, that diſorders the Equilibrium, is the cauſe of an infinite Number of Evils; the Pleuriſy, the dry Aſthma, proceed from this Cauſe: if we purge in theſe inflammatory Maladies, give Diureticks or Diaphoreticks, we ſhall augment the rubbings of the Parts, we ſhall irritate them more, and at laſt in the Tympany the Tumour of the Feet and Ventricle will augment; the dry Aſthma will degenerate into a Dropſy of the Breaſt, the dry Pleuriſy will form an Inflammation ſtill more dangerous; ſcirrhous Humours will change into Cancers, *&c.*

The Heart is not capable of propelling the Fluids; it has not force enough to ſurmount the Reſiſtance which all the Parts of the Body make againſt it, but it is the preſſure of the Membranes that propels the Blood continually; Exerciſe, which is ſo neceſſary to make the Fluids circulate, the Dropſy and Swelling of the Feet that happen to thoſe that ſpend a ſedentary Life, are a Proof of it. Hence it follows, that the forces of the Solids are very much above the force of the Fluids; and we cannot ſay, to confute this Propoſition, that the nervous Fluid moves the Heart, becauſe the exiſtence of ſuch a Fluid is without foundation. The Heart of a Frog ſeparated from the reſt of the Body, beats a long time without receiving this Liquor; beſides, Porters who eat but coarſe Aliments, not very proper to furniſh Spirits, have greater force than thoſe who eat very delicately; the contrary of which ſhould certainly happen: As for the reſt, it is this exceſs that occaſions inflammatory Diſeaſes, which troubles thoſe that work much, the fibrous Parts extremely collapſed, ſtop the Blood; if then we would make uſe of Diaphoreticks, we muſt firſt employ the Oil of ſweet Almonds, or other things that relax, otherwiſe we ſhould ſink the Solids more. This force that *Baglivi* ſuppoſes in the Solids, may be proved, as he thinks, by an infinite number of Examples; the Fibres that are much contracted, are irritated always by Diaphoreticks; hence often ariſe Pains, Deliria and Convulſions.

In Pleuriſies Spittings don't ariſe but when the Solids have been relaxed. A Delirium, which is an Inflammation of the Dura Mater, vaniſhes, when we plunge the Extremities in lukewarm Water; the Parts muſt then be very much collapſed, for there is then a Relaxation. The Veſicatories act on the Solids, and their Action added to thoſe of theſe Parts, produce ſometimes terrible Convulſions, and the Delirium augments; when the Parts have been too much ſunk, as in the Eryſipelas, there happen Tumours that yield only to Fomentations made with theſe vulnerary Herbs. In a Man who had a Fever, and died in Convulſions, the Fibres in the Muſcles were found extremely hard. The great force of Lions proceeds from nothing but the hardneſs of their Fibres; the irritations cauſed by Stones in the Membranes of the Ureters, are attended with dreadful Convulſions. Cold that we catch ſometimes at the Feet, cauſes frightful Cholicks which yield not but to the relaxation made by Emollients, and is irritated by other Medicines. All this ſhews the force of the Fibres, whoſe Motions may be compared to thoſe of the Cord of an Inſtrument: Theſe Fibres have a Centre where all Oſcillations join. This Center being diſordered, all is in confuſion. If the Dura Mater wrinkles, all the Secretions are diſordered; in the inferior Parts the Feet are cold, the Belly is bound, the Saliva flows not in a great Quantity; Indigeſtions, Leanneſs follow; Wakings, and extraordinary Meditations afford us Examples of it; what Diſorders don't Contractions of the Dura Mater cauſe in the Epilepſy? There was a young Man in whom the Epilepſy roſe to the Nape of the Neck and round the Jaw-bones, with an extraordinary Compreſſion; the terrible Symptoms that followed, left after them a wearineſs that can't be expreſſed. So true it is that the Contractions of the Solids cauſe Diſorders.

The Fibres have a great diſpoſition to contract; this appears by their Spring and by the Muſcles we examine in living Animals; beſides in Muſcles which have Antagoniſts, we obſerve a continual Effort to contract. The Fluid which flows in the Fibres, is a ſource of Forces which renew continually; the Cords on which we throw Water, have much force; the Fibres even of the Bodies, put into certain Liquors, harden the Fluid that flows there in a natural State, produce the ſame Effects; in Fibres thus diſpoſed the Oſcillations paſs from one to the other, and hence produce ſurprizing Symptoms; in Rage, Delirium, Melancholy, Cephalalgy, which have their Seat in the Dura Mater, extend through all the Body; Cephalalgies are followed ſometimes with Blindneſs, Tremours, Apoplexies; the Eryſipelas of the

Ventricle ſpreads an icy cold in all the Members, and ſuppreſſes the Secretions; the Pains of the Loins are carried to the Head, and round the Body, and then they are followed with Inflammations; the Pains concentrate the Pulſe, and ſtop the Action of the ſecretory Ducts; we ſee it in Evacuations which ceaſe by acute Pains. The Menſtrua ceaſe in Women, if they plunge their Feet into cold Water, and appear not often but with a relaxation cauſed in the Fibres by the Heat of lukewarm Water; if thoſe that have Ulcers at the Feet drink Wine, the Inflammation appears immediately on the diſordered Parts; if we walk with our naked Feet on a very cold Board, we perceive a violent Pain of the Cholick, which is cured by the relaxation of the Fibres. In nephritick Pains, on all the ſide where the Kidney is diſordered, is perceived the Irritation that occaſions the Stone, witneſs the Head-ach that attacks the ſide of the Head, which anſwers to the irritated Kidney. Violent Pains are ſucceeded by Convulſions, Cholicks and Cephalalgies, that often carry convulſive Motions along with them; Teeth that are bred very difficultly in Children, throw them into ſurpriſing Convulſions, and looſens often the Belly in an extraordinary manner: the Spaſmodic Agitations of the Meſentery cauſe Head-achs, Lethargies, Vertigoes; the ſharp Matters heaped together in the Inteſtines of Infants, throw them into convulſive Motions which we can't ſtop; but theſe two Motions can't continue by the Action of ſome Fluid; a Fluid divided in Canals of a Diameter infinitely ſmall, can't overturn a Machine as heavy as our Body; it is but a kind of Fire, according to its Defenders; but ſome poiſons, though cold, have extraordinary force.

It is not more likely that theſe Motions are raiſed, but as thoſe of the ſtrings of Inſtruments; ſee the Action of the corroſive, ſublimate and other Poiſons, all the Body is ſhaken in an inſtant by the violence of their Shock: Powder, Cornachini, and other violent Purgatives, if they are given to dry Conſtitutions, bind them more, cauſe violent Pains, ſuppreſſions of the Urine, Tympanies, ſuppoſing that the Impreſſions made by the Fibres be as thoſe that we make on the Cords of Inſtruments; all theſe Phenomena are unfolded; but if the Action of the Fluids is only made uſe of, we ſhall be very much embarraſſed: the ſympathetick Motions eſpecially will be inexplicable; the Belly and Head, are always affected when one of them is out of order; the Parts of the Breaſt and Pudenda have a ſecret relation that occaſions Diſtempers to leave one Part and affect the other; the Pains that happen to the Belly paſs into the Skin, and Maladies of the Skin are thrown into the Belly, *&c.*

We have juſt ſeen the Forces of the Contraction of the Solids and the Communication of their Motions, but we find no leſs ſurprizing Effects in their Relaxation. If the Ventricle loſes the Spring of its Fibres, Indigeſtions and continual Spittings follow immediately; the weakneſs of the Veſſels that change the Chyle into Blood, conduces to a Phthyſic: the Pilorus and relaxed Inteſtines let the Juice of the Aliments paſs; the feeble Reins cauſe ſuppreſſions of Urine, the ſame as the Bladder, if it loſes its Spring; at laſt this relaxation of Fibres in the Lungs produces the ſpitting of Blood, in the Eyes the loſs of Sight, in the Ear, Deafneſs.

This is the extract of a Book where there is no Method; the only Obſervations of Practice drawn to a Principle, are all that is valuable in it: as the Ideas found there are adopted by a Sect, I thought I ſhould not deviate from my purpoſe, if I made a pretty large extract of this Work, which the continual Repetitions, joined to the defect of Method, render diſagreeable to an accurate obſerver.

The Author, as we ſee, never talks but of Oſcillations; his Followers imitated him in this; they have but this Word to anſwer all the Queſtions propoſed to them; but I wiſh they would have cleared it. What are the Oſcillations of the Fibres? They are nothing elſe but their alternative Motions; but whence proceed theſe Motions? Are they natural to theſe Fibres? or are they produced by Cauſes which act upon them? We can't ſay that theſe Motions were natural to the Fibres; we ſee nothing in the ſolid Parts which can give them a Motion: It remains then that this Motion be then produced by ſome extrinſick Cauſe. I ſhall immediately be anſwered, that the Heart is not ſeen to be in Motion or Oſcillation by ſtrange Cauſes; we ſhall in another place ſpeak of the Principle of its Motions. Here it is ſufficient to anſwer, that they can't prove the Fibres of the human Body to act as the Heart; on the contrary, they owe to it all their Motions. Let us give an Example of it in the Membranes, of which *Baglivi* would have made a ſecond Heart.

The Meninges, according to *Baglivi*, are a ſecond Heart that balances the Motions of the other; but it can't be proved that the Pulſations obſerved there are an Effect depending on their Structure; they have Arteries which move them; they are placed on the Brain, in which there are many Veſſels whoſe Pulſations are very conſiderable; in a word, the Motions of theſe Membranes happen at the ſame time as thoſe of the Heart; they can't therefore prove that they are particular to them.

The Convulſions that happen in theſe Membranes, when we pinch them, and thoſe that they cauſe in the remaining part of the Body, are a ſecond Proof which *Baglivi* brings; but are there no Nerves in theſe Membranes? and does not the Irritation of theſe Nerves ſuffice to produce there divers Motions. As for the Convulſions which follow their Irritation, in the reſt of the Body, they don't ſuppoſe an Action particular in the Meninges; theſe Membranes cover all the Nerves, which are the Inſtrument of our Motions.

The Motion of the Meninges or Solids ſuppoſes an Error, which is, that all the Fibres are extended as the Cords of a Violin; it is true, that there is a kind of Tenſion, but in diverſe Situations theſe Fibres are not extended, *v. g.* when we bend the Spine of the Back forwards, the Muſcles of the Abdomen have no great Tenſion; nevertheleſs the ſenſibility is there the ſame; thus the Action of the Nerves can't depend on the Tenſion.

But that which demonſtrates the Tenſion of the Nerves is not the cauſe which tranſmits the Impreſſions of external Objects; it is the Action of the motive Power on theſe Nerves; for if the Impreſſions of Objects were carried to the Brain by the Vibrations of the Nerves, the Soul would tranſport in the ſame manner its Action into the Parts; but it would be abſolutely impoſſible

poſſible that the Soul ſhould move a Filament of Nerves, without moving an infinite Number of them; thus in willing to move a part, it would put all things into Motion, or at leaſt would agitate many; we may ſay the ſame thing of the external Objects that act on the Senſes.

Another Difficulty, which is not leſs conſiderable, is, that this Opinion ſuppoſes the Nerves are Filaments which we may draw from the inferior Parts to the Heart; nevertheleſs it is certain there are many Ramifications ending in Ganglions that are their Origin; but if this be ſo, how is it poſſible that the Vibrations which would agitate theſe Filaments, could carry the Impreſſions of Objects into the Brain?

This is not all; it is certain that the Strings of a Violin receive no more Impreſſions from the Bow, if we preſs all over their Surface; but the Nerves are preſſed on all ſides; thus we cannot compare their Action to that of the Cords of an Inſtrument: add to this, that the nervous Filaments are not diſpoſed in a right Line; there is no Curve but what they deſcribe in their Courſe, they make often even many Windings on lax Membranes, witneſs the left diaphragmatick Nerve, when it paſſes on the Pericardium: in ſuch a Caſe how would they have the Nerves receive Impreſſions, and tranſport them into the Head? This is the more impoſſible, as in their ſeveral Windings or Angles, the Nerves are fixed to divers Points, which we muſt look on as ſo many Bridges in the Syſtem of Oſcillations; but it is impoſſible, as we know, that a String of a Violin ſhould make theſe Vibrations paſs beyond the Bridge. But in bringing this Proof, I don't pretend to prove that the Nerves are extended; on the contrary, I ſhall ſhew that the nervous Filaments are very lax almoſt every where.

Theſe Proofs are ſufficient to confute the Opinion of thoſe that maintain Oſcillations; but they ſhew at the ſame time the ridiculous Explications that have been given to ſome Phenomena; the Tympany was examined by *Baglivi*; he believed that the cauſe of this Malady could not be found by common Syſtems; he imagined that the Fibres were irritated in the Abdomen, and this Irritation gave them a great Tenſion which obliged them to ſtraiten; the Fibres being ſtraitned occupy more Space, remove the one from the other, leave Interſtices between them; it is in theſe empty Interſtices that the Air is inſinuated; thus the Swelling is not an effect of the Air; but the Air is inſinuated only in the Vacuum it meets; this Explication is not ſatisfactory. Beſides, their not giving the cauſe of that ſtiffneſs of the Fibres, it ſeems that the hardneſs ſhould augment in the Texture of the Abdomen; nevertheleſs that is not perceived; beſides, the Tympany may be eaſily explained without all this. As ſoon as the Inteſtines come to be ſtraitened in ſome Place, the Air will accumulate between the Œſophagus and that Place; thus it will appear that the Air cannot go out through the Anus, whilſt it will enter anew continually with the Aliments; it will then be neceſſary that this rarefied Air, be always more preſſed by that which follows, and dilate the Inteſtines: the Tympany is nothing elſe but a ſwelling of the Inteſtines produced by the Air; there may be ſometimes a portion of paralytick Inteſtines that permit the Air to extend a little more than the other part of the Canal. *Willis* talks of a univerſal Swelling happening on the occaſion of a Wound on ſome conſiderable Nerve. *Baglivi* gives the ſtiffneſs of the Fibres, which contract, as a Cauſe of this ſwelling; but this is an Explication we cannot receive. Is it poſſible that the Fibres, in loſing their Communication with the Brain enter into Action? On the contrary they loſe their force; and it is this that occaſions the Swelling; for the Air inſinuated into the Body, is preſſed by the Spring of the Fibres and by the external Air: but when a principal Nerve is cut, the Parts where it terminates have no more force; thus they preſs not the Air, which, becauſe of this leaſt Preſſure will extend more, and will cauſe a ſwelling. There is ſtill a thing in which I can't agree with *Baglivi*; it is the Reflection of the Oſcillations. Can one conceive that the Vibrations of a String of a Violin go from one end to the other? Is it not all the String that vibrates when we touch it with the Bow? Oſcillations have been looked upon as the Undulations of a String that comes back, when they are arrived to one of the Ends; but we can't ſuppoſe Undulations in the Fibres of the human Body, which are tied to an infinite Number of others in their Courſe.

But what muſt the grand Queſtion, *viz.* if the Maladies proceed from the Solids or Fluids; to what, I ſay, muſt that be reduced to? It cannot be maintained that they proceed from the Solids only; the Fluids can of themſelves occaſion very irregular Motions in our Bodies; it is this we prove every Day, after having taken improper Aliments. Don't we ſee the Inteſtines agitated by Fluids that we take?

Why will not the ſame thing happen in the Veſſels? We muſt nevertheleſs own, that the great Spring of the Solids, or their Relaxation, are the moſt part of the time the cauſe of our Maladies. Does the Spring of Solids act with too much violence; are the more fluid Parts preſſed out from one Side and the other, and do there remain but groſs Parts that form Obſtructions every where? Is there too great weakneſs in the Solids, the Fluids can't flow, and form hence Surfeits, whence ariſe an infinite Number of Evils?

If Maladies ariſe partly from the Solids, and partly from Fluids, doth it not follow that the principal of the Motion is neither in the Solids, nor the Fluids only? We can't ſay that the Action depends on a Fluid only, neither on a ſolid Matter; but Nature formed ſuch a Machine in our Body, that the Fluids and Solids are equally neceſſary; for we can't find a beginning of Action in the ſolid Parts, but what is puſhed by ſome Cauſe; but we ſee no other Agent for this in the human Body than the Fluids; in like manner we can't ſuppoſe a Motion in the Fluids, if they are not propelled from ſome other Place; but we ſee no other Agent for this but the Solids. I ſhall perhaps be anſwered, that the Fermentation may give the Fluids a principle of Action; but I have already ſhewn that there is no fermentation in the Veſſels.

REMARKS *on the Brain.*

It were to be wiſhed, that the Structure of the Brain were more known to us, for we are as yet very ignorant of it.

Malpighi believed the cortical Subſtance of the Brain was compoſed of Glands; the Microſcope ſeems at firſt to favour this Opinion; by its help we ſee the cineritious Subſtance raiſed in ſmall Eminencies. When we boil a Brain, its Subſtance riſes in Moleculæ like unto Glands; we diſcover by the means of Ink we throw on the cortical Subſtance, ſmall elevations ſeparated by little ſlits; the putrified Brain preſents a Surface covered with ſmall Globules; there iſſues through the Orifices we make at the Skull a fungous Matter, which has ſomething of the Gland: the external Parts of the Brain change by a Dropſy into Spheres. Would not all theſe Reaſons prove that the Subſtance of the Brain is glandular?

Ruyſch is not convinced by theſe Proofs that the cortical Subſtance of the Brain is glandular; he believes, on the contrary, that all the Brain is but a continuation of Arteries which are diverſly folded, and at laſt form the Nerves with their Extremities; but there are not ſtrong Reaſons enough to ſupport this Opinion; the laſt Ramifications of the Arteries are not to be ſeen; the fineſt Injections can't go to the Marrow, at leaſt we always ſee its Colour is unalterable, what Liquor ſoever be thrown into the Arteries; notwithſtanding all this, this Oninion may be true, but it wants Reaſons to prove it.

We ſee by what we have juſt ſaid, how difficult the Structure of this marrowy Maſs, which is of ſo noble a uſe, is to be enquired into; all our Endeavours in its ſearch are vain: the Eyes aſſiſted by what Art affords, diſcover nothing but a Marrow where the Motions ought neceſſarily to be more ſlow than in the reſt of the Body; if Nature in the Conſtruction of this Marrow left not the Courſe it took in forming the other Parts, it were neceſſary that it ſhould have formed the Brain in one of theſe three following Manners; 1. There are either ſmall cellular Bags which receive the Marrow of the ſanguinary Veſſels, and that they ſend each in an excretory Duct, which is a nervous Filament; or, 2. That this Marrow heaped together into an infinite Number of Cellules, which communicate together as thoſe of the Corpora Cavernoſa, or of the Spleen, paſſes ſucceſſively through theſe Cellules to terminate at the Nerves, in like manner as the Blood terminates from the Corpora Cavernoſa in the Veins. Laſtly, The third manner after which the Train may be formed, is as follows: This Marrow can be nothing but a Maſs of Veſſels which are the arterial Extremities that change into Nerves, after having made many Circumvolutions in forming the Maſs of the Brain.

Be it as it will, the Brain is an Organ of our Thoughts; when we examined ourſelves how the Soul received the Impreſſions of Objects: we have ſeen that this marrowy Maſs was the Principle whence the Soul carried the Action into all the Parts of the Body; but the Motions which the animal Machine there acted did not unite in the Head. By the Proofs we have given it is evident that this reciprocal Commerce between the Soul and Body, is made by Motion; let us ſee what Organs are deſtined to carry this Motion of the Head into the other Parts.

The Nerves that ariſe from the Brain and Spine, are the Organs by which the Body and Soul act the one on the other; whilſt they are in the Marrow, they repreſent but a kind of Pulp, in leaving the Marrow they take a Covering that they are furniſhed with by the Pia

Mater; under this Cover they advance to the Dura Mater, which furniſhes them ſtill with another Coat. Theſe Coverings are environed every where by an infinite Number of Blood-Veſſels and Lymphaticks. Theſe Nerves are not compoſed of theſe Veſſels, but there is no doubt but that they owe to them many of the Phenomena we meet with.

The Subſtance of the Nerve encloſed into the two Membranes, is not different from the Subſtance of the Brain, it is nothing but a Marrow which extends through all the extent of nervous Ducts, and which is without doubt ſent from the Brain; but whether it is brought there by ſmall Veſſels, or encloſed in Cellules, cannot be determined. Perhaps the Nerves have all the ſame Structure, ſo that we can advance that the Pia Mater ſinks through different Pleats into the Cavity of the nervous Duct, and that in theſe Pleats is encloſed the Marrow; this Structure is that of the Optick Nerve, as we may ſee in drying it.

It has been a long time ſuppoſed, that the Nerves are ſmall Ducts, but we have had a great deal of difficulty to diſcover their Cavities, ſo that the Induſtry of Mr. *Lewenhoeck* has made the Cavities of the Nerves ſenſible, but this Diſcovery does not take away all the Difficulties. We may aſk, if theſe Cavities that this Obſervator hath diſcovered, are the Pleats of the Pia Mater, or whether they are particular Ducts.

It was thought that the Nerves were compoſed of Filaments continued from the Head to the Extremities where they are loſt; but this is not true; it is aſſured, that from Ganglions there ſeparate little nervous Filaments, which are not continued to the Brain; and hence we may conclude that the uſe of Ganglions is to furniſh new Branches of Nerves as ſo many ſmall Brains.

If we are puzzled about the Structure of the Nerves, we are ſtill more ſo when we muſt determine how they terminate. What may be obſerved is, that they are diveſted of a Part of their Coverings, and that they have the form of a ſort of Pulp. There are Authors who maintain, that they open and thus form Membranes; but this is only an Hypotheſis, and no Proof.

There were two Opinions on the Action of Nerves; the one attributes a Fluid to theſe ſmall Duct, which ariſe from the Head to the Extremities of the Nerves; the other gives them, as we have ſeen, the ſame uſe as the Strings of Inſtruments. The Reaſons we have given againſt this Opinion, evidently prove the contrary of this Opinion; it is not neceſſary to repeat them.

If the Nerves act as the Cords of Inſtruments, they can't have a Principle of Action but by the means of a Fluid which runs through their Cavity; we can prove the Exiſtence of this Fluid by many Reaſons. 1*ſt*, If we tie the Diaphragmatick Nerves in ſuch a manner that the Diaphragm loſes its Motion, we may render that Muſcle its Action in ſucceſſively preſſing the Nerves between the Fingers from the Ligature to the Diaphragm. 2*dly*, When we have for ſome time preſſed the Nerves between the Fingers, then we can no more excite Motion in the Diaphragm. From theſe two Experiments it follows evidently, that there is a Fluid in the Nerves which cauſes their Action; for we conceive not that we do any thing but preſs the Fluidum Nervoſum, when we preſs the Nerves with the Fingers. *3dly*, If there were not a Fluid that was the principal Cauſe of Action in the Nerves, the Parts would not loſe their Motion when we ſhould tie the Nerves; a large String of a Baſs-Viol becomes not incapable of Vibrations, when we tie it with a very fine String. *4thly*, It is impoſſible that the Motion can be tranſmitted from one Part to another by the means of a lax, curved, oblique Body, fixed to divers Points, if there is not a Fluid which flows into the Cavity of that Body; but the Nerves, as we have already ſaid, are lax, go in oblique Lines, form Circumvolutions; it is neceſſary then that the Motions they produce in Parts ſo diſtant with ſo much Rapidity, be produced by the Fluid that flows in the Cavity. *5thly*, We have ſhewn already that Convulſions can't happen without the Action of a Fluid, which flows into the Nerves: let us pinch, as I have ſaid, the Cords of Inſtruments, there will happen Vibrations; but theſe Vibrations, according to all the Laws of Motion, can't augment; on the contrary, they will always diminiſh; neverthelеſs if we cut Nerves in the middle, every thing is overturned in the Part where they terminate; it is evident then that the ſimple Vibrations which the Nerves are capable of, can never produce Convulſions.

But it will be aſked, whether this Fluid circulates? We muſt not doubt that it follows the eſtabliſhed Laws in all the reſt of the Body where the Fluids part all from a Place to return there again; ſince *Vieuſſens* thought to have found Ducts in theſe Veſſels which receive this Fluid of the Nerves, and he called them *Neuro-Lymphaticks*; but his Diſcovery is not confirmed.

This Idea of the Circulation of the Fluidum Nervoſum occaſions a great Difficulty; *viz.* if this Juice circulates, they will ſay it may be removed through the nervous Extremities; but if it can be removed, how can it be heaped in the Veſicles to cauſe muſcular Motion? To this we may anſwer, in the time that the Soul moves the Muſcles, it ſends a great Quantity of nervous Juice into the Veſicles: This great Quantity is renewed every Inſtant, and may inflate the Veſicles; whereas the ſmall Quantity of Fluidum Nervoſum which terminates thereby the Circulation, is incapable of producing ſuch a Swelling, becauſe its Maſs is neither large enough, nor propelled ſwiftly enough, not to be removed in an Inſtant.

The next Difficulty is, if the nervous Juice circulates always, it can't return; if this be ſo, how would the Impreſſions of Objects be carried into the Mind? For we have above mentioned that the Tenſion of the Nerves could not tranſmit the Motion; this Difficulty ſuppoſes that the Soul has no Perception in the Place where the Impreſſion of Objects is made; we have already ſeen what may be thought hereon. But we muſt not imagine that a Fœtus drawn out by the Feet, where it will make a very ſenſible Impreſſion, can remount the Fluidum Nervoſum into the Brain; the long extent of the Nerves which are the Organs of that Senſation, their divers Circumvolutions, the Quantity of Matter which it ſhould move, the Reſiſtance of the Sides of Nerves; all this invincibly proves that the Fluidum Nervoſum flows not up into the Brain; as the Nerves are a continuation of the Brain, the Soul perceives every where by a certain Motion in the Nerves; Nature was willing that the Soul might have perceived a certain Senſation, ſhe would at the ſame time have her ſo ſenſible in the Extremities, that there might be a Commerce between theſe Extremities and the Brain. What paſſes in the Spine ſhould confirm what I have been ſaying; the Nerves which come from it, don't continue in its Subſtance to the Brain, there is no appearance of it, conſequently the Impreſſions the Objects make at the inferior Extremities go to the Brain by means of the ſpinal Marrow; nevertheleſs if we ſeparate them from the Brain, it has no more Senſation; all this depends upon the Laws of the Creator, who was willing that the Places that were ſeparated from the principal Part, and where the Fluidum Nervoſum could not enter, ſhould be inſenſible: I might add to all this the Senſations we prove by the Nerves that terminate in Ganglions. How could theſe Nerves which do not reach the Brain, carry the Impreſſion of Objects there?

From the Circulation of the Fluidum Nervoſum, it ſeems ſtill to follow that when we make a Ligature, the Nerve ſhould inflate at bottom; but we have juſt anſwered this Difficulty. The Sides of the Nerves are very ſtrong, and the Filaments of the Fluid there encloſed, are infinitely ſmall: if we add to all this the ſlowneſs of the Motion of the Fluid, we ſhall ſee that no Swelling can happen by this Ligature; beſides, the Fluidum Nervoſum at the Ganglions, paſſes to the neighbouring Nerves, when it finds an Obſtacle in that which is tied.

But what becomes of this Juice, when it has reached the nervous Extremities? Perhaps it is immediately retaken through Veſſels; perhaps it overflows, and enters the Blood-Veſſels by Infiltration; perhaps a great part of this Juice evaporates;

porates; the great Weakneſſes we are troubled with ſometimes, may very likely be the effect of this Evaporation; then the Nerves being no more diſtended by their Juice, they can ſend no more of it into the Muſcles to cauſe any Motions.

How ſhall we by the Action of this Fluid explain the extraordinary Phenomena which ariſe, when the Nerves are wounded? 1*ſt*, The Nerves entirely cut retire, and hide themſelves under the Teguments which are under the Wound, cauſe Pains in the neighbouring Parts, and leave a Numbneſs in the inferior Parts. 2*dly*, The Nerves cut in halves produce Inflammations, Convulſions, Delirium and Fever; in a word, Inſenſibility or Gangrene in the Part.

The Nerve is nothing but a ſmall Bundle of Veſſels, Membranes, and infinitely ſmall Filaments; in theſe Bodies there is always a Spring; thus when we cut the Nerves, they ſhould retire under the ſolid Parts: in retiring they draw the neighbouring Nerves, and extend them; this Tenſion cauſes Pains in the neighbouring Parts; in ſhort, theſe Nerves hid under the Solids, and compreſſed by all that environs them, are ſhut and cloſed by their Extremities to that which they touch; then as they don't ſend their Juice in the Parts where they are extended before, it is not ſurprizing that theſe Parts ſhould be numb and fall away: the nouriſhing Subſtances can't be applied to the Solids but by Motion; for we have ſeen that the Motion ceaſes in one Part when we cut theſe Nerves. When we are bled through the Jugular Vein, we perceive ſometimes a numbneſs in the neighbouring Muſcles; this proceeds without doubt from the nervous Filaments which we cut then; but at laſt this numbneſs ceaſes.

What happens then? The cut Extremities will they re-unite? No, but the part of the Nerve which is retired not being very conſiderable, we do not perceive the want of it.

The Effects produced by Nerves cut in two, are more conſiderable and difficult to be explained; to find their Cauſe, we muſt remember that Pain is produced by the tearing of the nervous Filaments: When we cut a Nerve in halves, the cut Part retires, as we have already ſaid; for it cannot retire if it draws not very much the nervous Fibres to which it ſtill coheres, it will therefore produce a continual tearing; beſides, all the Nerve that ſuſtained before the effort of the Parts to which it is fixed, ſuſtains no more this Effort but by ſome Filaments; the Tenſion and Tearing muſt therefore augment. And this is the Cauſe of the great Pain that we feel.

But by what Cauſe are Inflammations and Convulſions produced? When the Nerve has been cut in two, the remaining Fibres are drawn more; they can't be drawn more, if the Ducts they form, and the ſanguinary Veſſels that accompany them, be not compreſs'd: During this Compreſſion the Fluidum Nervoſum will be heap'd above the torn Part; this Fluidum Nervoſum accumulated will be propelled ſtrongly into the Muſcles; 1*ſt*, By the Force that commonly propels them. 2*dly*, By the Action of the ſmall Arteries of the Nerves which being compreſſed, as we have ſaid, beat ſtronger; as for the Inflammation it will immediately be cauſed by the Action of theſe ſmall Arteries. As the Dura Mater inveſts the Nerves, this Inflammation may be continued to the Brain, where it cauſes a Delirium; in ſhort, if the Compreſſion the Nerves will ſuffer in the Inflammation becomes extarordinary, Life will be wanting in the Parts, and a Gangrene will be the Conſequence of it. This Inflammation extends becauſe of the Nerves that communicate with that which is torn, and by the pulling of theſe Nerves we ſee a great Number even of large Veſſels filled, which augments the Inflammation.

The Explication we have been juſt giving, ſhews the manner how the cauſtick Parts of certain Bodies act. 1*ſt*, Theſe acute Parts act not ſenſibly but at the arterial Extremities, and on the Nerves. 2*dly*, When an acute Part is applied to the Extremity of the Artery, it enters and preſſes the Sides of the Duct; the Sides thus preſſed form a Knob in their Canal that hence is ſtraitened; this Canal being ſtraitened, the Blood cannot paſs there in ſo great a Quantity, and conſequently accumulates; this Blood heaped up ſwells the Artery, and makes it beat more ſtrongly; this ſtronger beating produces an Inflammation, and propels more Matter into the neighbouring Fibres; there ſhould then be made an Evacuation in the Place where Veſicatories are applied. What we have ſaid of Arteries we muſt apply to Nerves, and we ſhall ſee what Miſchief very cauſtick Parts may cauſe there.

There is an infinity of Phenomena which depend on the Principle we have juſt eſtabliſhed; the Action of Purgatives that have poignant Parts, depends but upon what we have ſaid on the Subject of Veſicatories; Convulſions, whoſe Cauſe was ſo obſcure till now, are occaſioned but by the ſame Cauſe; if the Purgatives, *e. g.* produce a great Inflammation, the Agitation that this Inflammation will produce in the Nerves, will occaſion the Fluidum

Nervoſum to flow there more ſtrongly and unequally than before; thus the Muſcles that will receive their Action from theſe Nerves, muſt enter into Convulſion; if an Aneuriſm is formed on the Head, the violent Beatings of the Artery in compreſſing the Brain alternatively, will ſend the Fluidum Nervoſum with greater Force into the Nerves that are near this ſwoln Artery. The ſame thing may happen if Varices are formed on the Head; for the Arteries, which will be near theſe Varices, will be compreſſed, and conſequently be obliged to beat ſtronger. In ſhort, what happens to the Head may happen in another Place. If there are *e. g.* Aneuriſms near the Plexus's which are in the Abdomen, it would be impoſſible that the Fluidum Nervoſum be not expreſſed by the Nerves of the Plexus with greater force; thus there will be cauſed Contractions in the Muſcles, which they will receive from their Ramifications, or will have Nerves that communicate with theſe Plexus's.

After having proved the Exiſtence of a Fluid that acts in the Nerves, and explained the Effects, we muſt examine its Nature. There have been Authors who in ſeeing the Rapidity of our Motions, imagined that the Matter which was the Inſtrument of it, was of the Nature of the Light; but ſo ſubtil a Matter would be moſt proper to evaporate acroſs the Pores, than to flow through the nervous Ducts; beſides, it is without Foundation that they were perſuaded that this Matter flowed in the Nerves with a great Rapidity; that the nervous Ducts be filled with ſome Matter, be it what it will, provided it be fluid, is evident, it will ſuffice that this Matter receive a Motion at one Extremity to make a Reſiſtance againſt the other.

Authors who believed that the Fluidum Nervoſum, that ſerved to our Motions, was a ſort of Nitre or urinary Spirit, talked but according to chymical Prejudices; nothing diſcovers to us in the Nerves this nitrous or urinous Spirit, its ſharpneſs would wound the fine Texture of the Nerves and Brain; beſides, if we even turn to Chymiſtry, we ſhall ſee that by the Analyſis we take more of the volatile Salt from a ſmall Quantity of Urine than of all the Maſs of the Brain; nevertheleſs the contrary ſhould happen, ſince it would be the Brain which (according to this Hypotheſis) would be the Receptacle of the urinous Spirit. This Error gave riſe to many others. Spirits heated by the Fires of Laboratories, have found in the Head a Mean by which the Spirits that animate the Nerves are ſublimated. Many have looked on the Subſtances that exhale from the odoriferous Bodies as having ſome relation with theſe Spirits; for, as they believe, theſe Subſtances change into animal Spirits, and nouriſh them. Is it not more natural to ſay, that the odoriferous Bodies move by their Action the fine Texture of the Nerves, and that they there cauſe to flow by this Agitation the Fluid that was there before in a ſmall Quantity?

There are other Authors who advance, that the Air received in the Cavity of the Nerves was the true animal Spirit: This Opinion is much leſs reaſonable than the others we have mentioned; it ſuppoſes that a Body is inſinuated every where, and that by its Spring 'tis very proper to tranſmit the Impreſſions the Extremities of the Nerves receive; but we muſt not believe that there is more Air in proportion in the Nerves than in the other Parts of the Body; we may convince ourſelves of it in expoſing them in the Air Pump; we ſhall not ſee that from this

Fluidum Nervoſum there is raiſed Globules of Blood; on the contrary, there is leſs of it raiſed.

In ſhort, the moſt part of Authors believed that the Fluid which flowed in our Nerves ſerved our Motions, was a very ſubtil one, and very different from that which we ſee proceeds from the Nerves of the Tail of Oxen, when we cut them tranſverſely; but I know not why ſuch a kind of Fluid would not be proper to produce the Motions of our Body; it is fluid enough to run thro' the Ducts that are in the Nerves: Thus as ſoon as by this Action of the Soul this Fluid will be propelled, the Gout, that occupies the Extremity of the Nerve, will act againſt this End, and fill the Veſicles of which we have been ſpeaking in treating of the Action of the Muſcles. If the Arteries ceaſed to beat, this Fluid would not be propelled into the Nerves; for there is nothing but the Motion of the Blood that can give it the Motion of Progreſſion. *Malpighi* obſerved alſo on himſelf, that the Pulſation of his Arteries being intermittent, his Eyes became for an inſtant inſenſible to the Impreſſions of the Light, and that after his Pulſe had been for ſome time interrupted, there was a total Languor over all his Body. We may hence ſee that *Willis* was a Perſon who the leaſt underſtood the Action of the Fluidum Nervoſum. This Phyſician, but nothing of a Philoſopher, looked upon animal Spirits as on a Matter in a continual Motion, that it flowed with Violence towards the Brain, and produced Effects like thoſe of Gunpowder. It is on theſe fine Imaginations that *Willis* founded the Theory of Phyſick. We may hence judge of the Succeſs of his Remedies, which he always applied according to theſe Ideas. King *Charles* II. often ſaid ſmiling, *That that Phyſician robbed him of* *more Subjects than an armed Enemy.* Theſe are the Organs ſubſervient to the Motions of our Body, and which make us perceive Objects. I would not ſpeak here but of what is purely Mechanical; there remains ſtill an infinite Number of Things that we cannot explain; but what we can ſee between the Nerves and their Origin, preſents to us every where a ſurprizing Induſtry in the Hand that formed our Body. 1*ſt*, The Brain and Cerebellum are the Reſervoirs where is filtrated the ſame Fluid that carries Motion through all our Limbs; it was then of abſolute neceſſity that no Compreſſion happen in theſe Parts; for this Reaſon the Brain is divided into two Parts that are ſuſtained by the Falx, when we lie, and when the Head receives ſome lateral Motion; the ſame are the poſterior Lobes ſuſtained by the Tent, ſo that they fall not on the Cerebellum: the Ventricles ſerve ſtill to hinder the Compreſſions; the Brain preſſed on one Side may yield on the Side of theſe Cavities, which are always ſprinkled by a Liquor that is filtrated in the Choroides Plexus, by little Bags that are a kind of particular Glands: the Fluid ſoftening thoſe Ventricles, is propelled in the Funnel by the preſſure of theſe Sides, and is thrown into the Jugulars; in the Cerebellum the Maſs is very ſmall, upon which account there was no occaſion of Ventricles as in the Brain. 2*dly*, This is not the only Artifice which Nature made uſe of to hinder the Brain's not being compreſſed. In this View it form'd a round Box to encloſe it. This Figure hinders the Cranium from ſinking lower. As for the ſpinal Marrow it has a Rampart, and is free from all Preſſure; the Bodies of the Vertebræ form for that purpoſe a very ſtrong Canal. 3*dly*, To avoid the Compreſſion, Nature would not have the Carotid Arteries and Vertebrals accompany their Veins, as in the reſt of the Body, and therefore pointed out a different way, becauſe it would have been dangerous had they formed a mutual Obſtacle in paſſing through the ſame Holes. *4thly*, The Nerves, which take their riſe from the right Side, go to the left; and thoſe from the left to the right. Hence when we receive a Blow at the right Side of the Head, the left Side is obſerved to be paralytick. *5thly*, If we compreſs the Brain, or cut it to the medullary Subſtance, the voluntary Action of the Muſcle is interrupted, the Memory and Senſes are extinguiſhed, but Reſpiration and the Motion of the Heart ſubſiſt: As for the Cerebellum, if we do the ſame thing, Reſpiration and the Motion of the Heart ceaſe; hence it follows, that the Nerves deſtined for voluntary Motions ariſe from the Brain, and that the Nerves, whence depend the ſpontaneous Motions, ariſe from the Cerebellum. *6thly*, The Maladies of the Head depend all upon the Compreſſion; the Pain in the Head is cauſed by the Blood which cannot flow freely, and therefore cauſes a great Pulſation in the Arteries; we alſo find in dead Bodies, who when alive were ſubject to theſe Evils, the Veſſels much diſtended, and filled with a grumous Blood. If this ſwelling augments ſo as to occaſion a great Compreſſion, an Apoplexy would enſue, for then the nervous Part could be no more propelled into the Nerves that ſerve to the voluntary Motions; whilſt this Preſſion will not extend to the Cerebellum, Reſpiration and the Pulſation of the Heart will ſubſiſt. As for the Epilepſy it differs not in its Caſe from the Apoplexy, but in that the Preſſure is not the ſame: Let us ſuppoſe an Artery forms an Aneuriſm; this Artery being ſwelled will beat extraordinarily, and by theſe Pulſations will make the Fluid flow with force into the Nerves; extraordinary Convulſions therefore will be the Conſequence of this. The ſame may happen by Varices, for theſe Varices will compreſs the neighbouring Arteries, which by the Compreſſion will ſwell and beat ſtrongly; hence we ſee an Apoplexy may follow an Epilepſy. A Palſy often ſucceeds the Maladies we have mentioned, it differs not from thence but in that the Compreſſion ſubſiſts always uniformly in the Nerves; by the great Motion we ſuffer in theſe Diſeaſes, there happens by ſome Diſorder that a part of the Marrow which gives riſe to certain Nerves, is found always compreſſed; from this Compreſſion follows a Palſy in the Members where theſe Nerves terminate. As for Convulſions they are nothing but a kind of Epilepſy, but they can find a Cauſe far from the Brain, as if an Aneuriſm happened, for example, near the nervous Plexus. *7thly*, In thoſe who have died of this Malady, we ſee a great Quantity of Serum extravaſated in the Brain. There were Phyſicians who looked on this Liquid to be the occaſion of this Diſeaſe, but it is only the effect of it; the Blood being ſtopped in the Veſſels, the aqueous Part is preſſed out, the Brain therefore muſt ſwim in the Serum. *8thly*, We ſee the Nerves are ſent into the Muſcles to cauſe Motion in thoſe; but there are more Branches in proportion in the Plexus's that follow the Veſſels. Whence proceeds this? It is certain the Arteries have occaſion for a great deal of force to propel the Blood; thus it was neceſſary to give it Nerves, to make them act. *9thly*, The Nerves are the only ſenſible Bodies; but how comes it that the Brain from whence they riſe is not ſenſible?

ſible? As this depends upon the Union of the Soul and Body, we can give no other Reaſon but that the Marrow of the Brain forms the Nerves, and it is only by theſe Nerves that Senſation is performed. 10*thly*, As, according to the Principles we have ſuppoſed, the Nerves act by the Fluid which flows through their Cavity, it is a neceſſary Conſequence that the Nerves can act no more, when they will be tied; but we don't ſee that the Senſes muſt there be extinguiſhed; for if the Soul thinks every where, whence comes it that it will no more be ſenſible of the Impreſſions of Objects, when the Nerves will be tied? All this again depends upon the Laws which unite the Soul to our Body; the Pain is not occaſioned but by the tearing of the Solids: if it were not neceſſary to cauſe Pain, but to repel the nervous Fluid, it is certain that when we tie the Nerves, we ſhould feel a great Pain; for it then ſhould flow back with a great deal of force, ſince the Efforts of the Arteries that accompany them would make them return with greater force than many Bodies whoſe Action cauſes Pain; far from thinking that the Reflux of the Fluidum Nervoſum occaſions the Pain, there are occaſions where the Fluid flows into the Nerves in a larger Quantity, and where we perceive an extraordinary Pain; I require no other Examples but a few certain Convulſions, as the *Tetanos* in this Malady, where the Muſcles of the Spine are equally extended with much force; what occaſions their ſtraitning, if not the Fluidum Nervoſum, which flows in great Quantity? And is it not even this great Quantity of Fluid that cauſes this Pain? 11*thly*, When the Fluidum Nervoſum flows equally every where, we ſee that all the Parts muſt be equally extended; but as ſoon as more Fluid will flow through one Nerve than through another, the force of the Parts, where the Nerve will terminate whoſe Fluid will flow more rapidly, will be more conſiderable; and this is what happens when we move; the Soul makes the Fluidum Nervoſum flow into the Part that is moved more abundantly than in that which is immoveable. 12*thly*, Whilſt the Fluidum Nervoſum is propelled with a certain force every where, we may move eaſily, but when this Juice is exhauſted, we ſleep. Let us examine what is Sleep.

Sleep.

Sleep, or that involuntary Action occaſioned by a long Fatigue, has always appeared difficult to be explained, yet it is but a Series of Principles we have eſtabliſhed. That our Body may move with Facility, it is neceſſary there ſhould be ſome Fluidum Nervoſum ſent into the Nerves, and that there be no Obſtacle to ſtop it in its Courſe. If theſe two Conditions are wanting, we ſhall be inactive.

When we move, the Fluidum Nervoſum diſſipates by degrees, for the Soul continually ſends a great Quantity of it, which never returns; it is neceſſary therefore that after long Labours no more nervous Juice be found in quantity large enough to move our Body. Perhaps it will be objected againſt me, that in eating very much and often, we could ſupply this Drowſineſs, and that nevertheleſs Experience ſhews the Aliments cannot diſpoſe us to ſleep, but we muſt have ſome time to prepare the nervous Juice; beſides, the Aliments taken to exceſs throw us into a ſleep. We will hereafter

after ſhew what is the Cauſe of theſe Phænomena.

That our Fluids may flow in our Bodies with eaſe, the Fibres of our Veſſels muſt have a certain Tenſion, if it were not extended, they could not propel the Fluids; the Fibres loſe their Tenſion by hard Work, becauſe the Juice that filled and extended in filling them, continually evaporates; theſe Fibres not being more extended fall the one on the other; and hence it follows that thoſe of the Brain, which are much ſofter than thoſe of the others, muſt more eaſily collapſe; when the Maſs of the Brain will be thus collapſed, the nervous Juice will not be able to paſs into the Nerves as before; thus to this Facility of acting, which we perceive when we have enjoyed ſome Reſt, Labour will occaſion the Succeſſion of a Languor, which will at laſt oblige us to reſt.

We have ſeen in ſpeaking of the Nerves, that when they were compreſſed they could give no more Motion to the Body; we have juſt proved that they are compreſſed at their Origin by the collapſing of the Brain; but there is ſtill another Compreſſion. When we have waked a long time, Perſpiration continually takes away the moſt part of the Blood, that which is the thickeſt remains in the Veſſels, this more groſs Matter permits not the Blood to paſs eaſily through the Extremities of Arteries that are in the Brain; theſe Arteries ſhould therefore fill, and filling ſhould compreſs the Origin of the Nerves of all the Parts. This Compreſſion neceſſarily produces a Numbneſs in all the Body, ſince it is an hindrance of the Fluidum Nervoſum.

Theſe three Principles being laid down, we eaſily explain all the Phenomena preſented to us by *Sleep*; but before we enter into a Detail, we muſt anſwer one Difficulty which occurs at firſt, *viz.* the Nerves, which ſerve the Motion of the Heart, ſhould be compreſſed as the others; nevertheleſs far from being ſo, the Heart beats with a greater force. But the Nerves that give the Heart its Action, ariſe from the Cerebellum; for the Subſtance of the Cerebellum is very ſtrong, there is no Cavity there, the Arteries that carry the Blood to it are not as large as thoſe of the Brain; they are not ſhut up as in the Pleats of the Marrow; the venous Sinus's can't cauſe any Compreſſion there; as for the Brain, it is ſoft, interrupted by ſeveral Cavities, filled with large arterial Trunks, expoſed to the Action of almoſt all the Blood that enters in the Cranium, and is in a very great Quantity. All this ſhews that the Brain ſhould loſe its Tenſion, collapſe, be compreſſed, while the Cerebellum acts as uſual; nay, as the Blood finds an Obſtacle in the Brain, it muſt flow with a little more force towards the Cerebellum: Beſides, upon account of the ſame Obſtacle the coronary Arteries that give in part the Action to the Heart, ſhould receive more Blood. All theſe Reaſons evidently prove the Motion of the Heart muſt even augment during ſleep. As for Reſpiration, what we have ſaid of the Brain and Cerebellum proves that it muſt ſubſiſt during Sleep the ſame as the Action of the Heart; the Nerves which ſerve the Motion of the Breaſt, come from the Cerebellum in the ſame manner as thoſe from the Heart. Let us now enter into the Detail of the Phenomena which Sleep offers to us.

When we have been fatigued by Labour, or have waked long, the nervous Juice is diſſipated, the ſwoln Veſſels in the Head compreſs the Origin of the Nerves, the Brain that has loſt its Tenſion, falls down and augments the Compreſſion; all this muſt produce in the Nerves the ſame effect as a Ligature; the Senſes muſt therefore be dull, the voluntary Motions ſhould become hard, and at laſt ceaſe entirely: As the Neck is not ſuſtained but by the Extenſors, and that there is need of an Action to keep them ſtrait, the Head ſhould by its weight hang down, becauſe thoſe Muſcles act no more, the Eyes muſt ſhut, for if they were open, it would be neceſſary that the Muſcle that raiſes the Eye-lid be ſhortened; during Sleep it receives not nervous Juice enough for that, therefore it relaxes and lets the ſuperior Eye-lid fall down; in a word, all the Limbs are lax, ſince the Muſcles that move them receive not as before the Fluid that animates them. From all this it follows, that Affections of the Mind depending on the Activity of the Senſes, muſt ceaſe while we are aſleep.

Whilſt Action ceaſes in the Muſcles that are ſubject to the Will, Motion becomes more ſenſible in the Heart, and Organs of Reſpiration; we have accounted for it elſewhere; but we muſt obſerve that the Muſcles being lax in the Extremities, propel the Blood no more; the Fibres fallen down ſhut up the Veins; it happens then that the Heart finds more Reſiſtance: but, as we have proved it in talking of the Pulſe, the Heart can't find any Reſiſtance, but its Action muſt become greater. Theſe Obſtacles which are in the Extremities, occaſion the Circulation to be ſtronger in the Viſcera; for the Blood not being able to continue its Way towards the Extremities, is thrown in greater Quantity into the lateral Veſſels which it finds in its Way, *i. e.* into the Veſſels that expand in the Abdomen.

In what we have juſt now mentioned we

find many very curious Phenomena. 1*ſt*, Tranſpiration augments, and other Secretions diminiſh; beſide that the heat of the Bed in rarefying the Skin may open the ſecretory Ducts, we muſt obſerve that the Blood which is thrown in greater Quantity into the Viſcera of the Abdomen, ſwells the Arteries: This ſwelling compreſſes the ſecretory Ducts which then can receive no more the Fluid they were uſed to filtrate, but the ſecretory Ducts of the Skin are not compreſſed after the ſame manner, becauſe they exteriourly are ſupported but on Air; beſides, they are for the moſt part but arterial Extremities, or their Pores; thus nothing could hinder the Fluids continuing their Way through theſe Orifices. 2*dly*, The Parts are nouriſhed better during Sleep; for leſs Solids are looſened then, ſince the Muſcles are inactive, the reſt which reigns throughout the Body, occaſions that the nouriſhing Parts may be better applied to the Solids, for they find no Obſtacle in the Motions that the Muſcles, when they act, impreſs on thoſe Parts which ſhould repair the nouriſhing Juice; while the Obſtacles diminiſh, the Force that applies the nouriſhing Juice to the Solids augments, as we have proved, for it is the Action of the Heart; beſides, by that ſtronger Action of the Heart the Chyle changes eaſily into Lymph and Blood; this follows from what we have eſtabliſhed when ſpeaking about the Circulation: Beſides, the Blood circulating no more, if we may ſo ſay, in the Extremities, and not being able to paſs as before through the Brain, it is reduced to circulate almoſt through all the Viſcera of the Abdomen; but in following this Courſe which is the ſhorteſt, it is obliged to paſs the oftener through the Lungs, which are the true Organs that prepare the Chyle, and change it into a nouriſhing Juice. In a word, the Veſicles that encloſed the Fat, and were emptied by the Action of Muſcles fill by degrees with a new Oil; the little Arteries that the Muſcles had too much impreſſed by their Motions, open by degrees: all, in ſhort, fills, and is repaired becauſe of this ſoft and uniform Motion we perceive during Sleep; on the contrary, all is deſtroyed and emptied in our Body by the Irregularity of Motions. *3dly*, During Sleep the Fluidum Nervoſum filtrates by degrees, and flows in its Receptacles; and at laſt, after ſeven or eight Hours reſt, there is a Quantity large enough to wind our Machine up again. *4thly*, That which is loſt by Tranſpiration during Sleep, is more in Quantity than all the aqueous Parts of our Aliments and Blood; the moderate Motion then in our Body, cannot looſen but very few oily and thick Parts; on the contrary, it fixes more thoſe ſort of Parts, as we have proved; but when we wake, the Action of the Muſcles cauſe Matters to evaporate that compoſe the Solids of our Body; hence it follows, that when we ſleep we have no need of eating, as we have when awake; this will appear ſtill more clear, if we conſider that the nervous Juice of the Muſcles is not loſt, ſince it is not ſent there, and that all fills and is repaired, as we have proved; we may be a long time therefore without eating, provided we but ſleep; but if we wake, and move, we muſt eat often. *5thly*, The Fibres of the Brain of Infants are very ſoft, they will collapſe therefore ſooner than in old Men in whom they are dry; which is the Reaſon that the Fœtus ſleeps always in the Lap of its Mother, and that Infants ſleep more than Adults and Old Men.

Beſides, the ſoft Fibres of Infants have not force enough to divide the thick Subſtances which are in the Veſſels; there muſt then be formed a Plethora in their Brain, and the Compreſſion cauſed by that Swelling will cauſe ſleep. *6thly*, If we ſleep too long, Tranſpiration ſtops, our Head is heavy, we are weak, become fat, and Phlegm is gathered: We have ſaid that the Veſicles of the Fat fills during Sleep the ſame as the glandular Filtres; theſe Veſicles and Glands filled, compreſs the ſecretory Veſſels, and hinder them thus from receiving the Liquor that they carried out; beſides, the aqueous Part that diſſipates almoſt during Sleep, deprives the Blood of a Vehicle; thus the groſs Parts muſt form a Plethora every where: Tranſpiration muſt ceaſe therefore in the ſame time. As for what regards the Head, the Veſſels ſwell always more when we ſleep; in a word, by long Sleep the Swelling becomes ſo great, the capillary Veſſels and the Veins are compreſſed by the large Arteries, the Blood cannot therefore return, and we neceſſarily muſt be heavy; but this ſame Compreſſion that hinders the Blood's return, ſtill ſtops the nervous Juice at the Origin of the Nerves; thus the Juice will not be able to flow in the Extremities, and we ſhall find ourſelves without Strength, ſince the Soul cannot ſend that Fluid to move the Muſcles; but at laſt the Pulſation of the Veſſels will be ſo conſiderable, that their Pulſations will cauſe diſagreeable Impreſſions which will wake us in Surprize, and will hinder us from ſleeping more. As for the Fat, it is evident it muſt be gathered in a greater Quantity in thoſe who ſleep too long; for as no Diſſipation is formed by the Action of the Muſcles, neither by the Tranſpiration, the oily Veſicles will neceſſarily fill more; this

Defect of cutaneous Tranſpiration occaſions the Phlegm to filtrate in greater Quantity; this follows from what we have ſaid on the ſubject of Secretions; beſides, the Blood always ſtopping more in the Head, the Veſſels which run to the pituitary Filtres receive more of it, and bring them more Phlegm. *7thly*, When we wake, we yawn, extend the Arms, are more active, have more vivacity of Spirit; as the nervous Juice did not flow in the Muſcles during ſleep, all their Fibres were languiſhing; we muſt therefore contract them all to open the Paſſage for the nervous Juice that was filtrated in the Brain: but this is made by the Contraction they enter into when we extend the Members: yawning proceeds from the ſame Reaſon, as we may ſee by what we have already ſaid. This nervous Juice which enters in the Muſcles, and is gathered in a great Quantity, occaſions greater Agility, for the Soul may ſend a great deal of it in the Nerves to move the Parts; thus much would the ſupreme Being have the Vivacity of Spirit depend on the Motion of the Fluids in the Brain. But this Motion is much more eaſy and large, when there has been gathered there a vaſt Quantity of nervous Juice, and when the Fibres have retaken their Tenſion in filling; and this is ſo during ſleep.

Our Principle, as we have ſeen, is eaſily applied to all the Phænomena which ariſe from Sleep; it is ſtill confirmed by the Action of Cauſes that make us drowſy. 1*ſt*, Solid and tenacious Aliments taken in too great a Quantity, make us ſleep, becauſe the Aliments difficult to divide form a thick Fluid that cannot eaſily paſs through the arterial Extremities of the Brain; hence they occaſion a Plethora which cauſes Compreſſion; beſides, as theſe

Matters are tenacious, they ſtop Tranſpiration, as *Sanctorius* obſerved; hence it follows, that there will be a Plethora in the Brain, and conſequently a Compreſſion. 2*dly*, Fermenting Liquors make People ſleepy, becauſe theſe Liquors contain Principles that rarify very much; theſe Principles in occupying much Space dilate the Arteries of the Brain, and compreſs it conſequently; it is thus that Opium acts as well as very ſpirituous Aromaticks, that have not much Sharpneſs. 3*dly*, Subſtances that allay Pains, procure a ſoft Sleep; the Soul by the Laws which join it to the Body cannot perceive the Pain, becauſe that it doth not cauſe Motion in the Brain; but when the Pain ceaſes, the Fibres of the Brain being relaxed collapſe, and cauſe the Compreſſion that occaſions ſleep; hence we may ſee, that contrary Remedies may occaſion ſleep; when ſour Milk cauſes Convulſions and Cholicks in Children, the Abſorbents that produce the Acid, produce ſleep; in Maladies whoſe great Heat is the Principle, the refreſhing Remedies will be ſomniferous, &c. 4*thly*, The great Heat throws into Drowſineſs the Rarefaction that it cauſes in the Fluids, the Evaporation of the moſt fluid Parts of the Blood, the Relaxation they produce in the Fibres, muſt neceſſarily produce Sleep. Cold may occaſion the ſame thing, becauſe in ſtopping Tranſpiration, it cauſes a Plethora that compreſſes the Brain. 5*thly*, The Tranquillity of the Mind procures Sleep; for the Brain is not then agitated by the Soul. Thus abandoned, if we may ſo ſay, by itſelf it may collapſe, if its Fibres are not well extended; it is only in calming the Mind that the Noiſe of the Rivulets and Winds lull us to ſleep. This dumb and uniform Noiſe draws our

Attention without moving us, and hence removes from our Mind the Thoughts that might trouble us ; we may ſay the ſame thing of the Sounds of Inſtruments which produce this effect. *6thly*, Whatever can hinder the Blood from circulating into the Brain muſt neceſſarily make us drowſy ; for then the Fibres become flaccid and collapſe ; hence great Evacuations are followed by Sleep. *7thly*, All Accidents that may cauſe a Compreſſion in the Brain, ſhould cauſe Sleep. Thus Obſervations ſhew us, that Abſceſſes, extravaſated Fluids, Contuſions, and Sinkings of the Cranium produce Drowſineſs.

Juſt as all that compreſſes the Brain, and oppoſes the Paſſage of the nervous Juice into the Nerves, produce Sleep, whatever will produce a contrary Effect, will keep us from Drowſineſs ; Paſſions, Pain, ſharp and ſpirituous Matters always put us in a State where the Fibres are found extended and agitated. We eaſily ſee that ſharp Matters can produce this Motion ; but as for Paſſions and Pain, the Being that keeps the Soul and Body in a mutual Dependence, can only teach us the manner in which the Brain is troubled when the Soul is agitated ; but whatſoever it be, the effect of Paſſions is always a Motion in the Brain. This Motion makes the nervous Juice flow, and hinder the Brain from being compreſſed by the Veſſels, or collapſing of itſelf.

REMARKS *on the Eye.*

The Skin and Epidermis which runs over the Orbit, form the Eye-lids, they cover two Muſcles that unite each Corner of the Eye, and ſhut them when they contract ; under every one of theſe Muſcles there is a Cartilage that is alſo fixed in the ſame manner to the Angles of the Eye; theſe Cartilages keep the Eye-lids firm, ſo that theſe Cartilages are covered within by a fine Membrane in which we ſee the Orifices into which the lacrymal Gland is diſcharged; on the Borders that are garniſhed with Hair, Glands are found which filtrate a Kind of Wax to hinder the Effuſion of Tears.

To form an Idea of the Structure of the Eye, let us ſuppoſe that we raiſe the Eye-lids: The firſt Membrane we meet with is that called *Conjunctiva*, becauſe in expanding on the Eye and afterwards under the Eye-lids, it is the tie of it; this Membrane being raiſed, we find the Globe of the Eye; the leſs Part of that Globe is environed with the Tendons of four Muſcles that re-unite to the Cone at the bottom of the Orbit; two of theſe Muſcles are lateral, the other two are the one inferior the other ſuperior; they ought therefore to draw the Eye upwards, downwards, and towards the Sides, ſince they act ſeparately. From the bottom of the Orbit there ariſes another Muſcle that paſſes into a Ring, which is at the internal Angle of the Eye; it mounts afterwards on the Globe, where it fixes; from the inferior Bottom of the Orbit, near the Noſe, parts another ſmall Muſcle which goes towards the external Angle, and behind mounts on the Globe of the Eye, and fixes under the Abductor; theſe two Muſcles draw the Eye towards the Noſe, when we look at its Point.

When we have taken away all theſe Muſcles, we find the firſt Membrane that inveſts the Eye: to follow it well, let us take it from its Original. The Optick Nerve enters into the Orbit covered with the Dura Mater; after it has gone out of the Hole this Membrane ſwells, and forms a Globe; it is very hard, and for which reaſon we call it Sclerotic, but at the anterior Part it becomes tranſparent, and in that Part takes the Name of Cornea.

The Pia Mater, which is the internal Membrane of the Optick Nerve, follows the Membrane of the Dura Mater, and forms a ſecond Globe with it; but when it is come to the Cornea, it divides and ſinks behind; at the Place where it draws back, it ſeparates into two; the Internal is thrown on the vitreous Humour, and runs to the Cryſtalline; it is this ciliary Ligament that is bordered with a Circle of Veſſels; the external, after four or five Lines, ends, and by that means leaves a Hole in the middle, has divers Colours, and forms that which we call Iris; the Space that ſeparates the Iris from the Cornea, is called the Camera anterior; but there is no interval between the Iris and Cryſtalline; thus the Camera poſterior is but a Chimera.

The Subſtance of the Nerve after its entry into the Eye, interiourly at the Side of the Axis, forms a Membrane which ſerves for the Cryſtalline, and which we call the Retina; large Arteries that accompany it at its entry, extend on all Sides with it; we have even there obſerved lymphatick Veſſels.

The interior Part of the formed Globe, as we have juſt deſcribed it, is filled with a Fluid; the Matter that fills the poſterior Part of the Eye is called the vitreous Humour; it is encloſed in Veſſels continued to thoſe that filtrated it, and receive it again to carry it back into the Veins.

This Humour fills all the Space which embraces the Retina, in an elliptick Cavity on the forepart; on this Cavity is applied the

Cryſtalline, which is a true Lens compoſed of Veſſels which ariſe from thoſe that are in Streaks on the ciliary Proceſſes; the Humour is carried into the Streaks by continued Veſſels. The Cryſtalline is fixed in its Cavity by the fine Membrane that envelops the vitreous Humour; the Space that is extended from the Cryſtalline to the Cornea, is filled with a Fluid called the *Aqueous*, which flows continually through lymphatick Arteries, and is repumped by Veins.

All theſe Humours ariſe from the ſanguinary Veſſels that enter near the Root of the Optick Nerve, and which, after being come to the choroide Membrane, forms many Circumvolutions, perfectly well deſcribed by *Ruyſch*; theſe Veſſels ſecrete a blackiſh Fluid in the internal Surface of the Choroides and Uvea. The Nerves, after having entered near the Optick Nerves form Rays that embrace the Globe of the Eye.

This is the Image of that wonderful Organ, deprived of which, Animals would be in entire Darkneſs; in a word, to know the uſe of its Structure, let us in a few Words examine the Nature of Light, the Colours that it forms, and the Rules it follows in its Motions.

The Light or the fiery Matter is nothing but a gathering of very ſubtile Bodies, that part luminary Objects with an incredible rapid Motion; this Matter is encloſed in all Bodies, it eſcapes as ſoon as it has its Liberty; it ſeems that it is compoſed of very elaſtick Parts, which are ſhot forwards, by their Spring, as ſoon as they are free from the Bonds that tie them.

The Differences found between theſe Senſations or Colours, proceed from the Difference of the luminous Corpuſcles; there are Rays that excite in our Eyes one Senſation, others excite in it a different one; in ſhort, every Senſation made in the Eye is occaſioned by different luminous Bodies.

This difference of Rays may be eaſily proved. Let us take a Priſm, and apply it to a Hole made in the Window of a dark Room, the Rays that will paſs through that Priſm will be divided, ſome will be red, others blue, *&c.* if we intercept all the Rays except the red; if we make theſe Rays paſs through Glaſſes of different Forms; if we make them fall on different Bodies, they will not change in relation to their Colour. We obſerve the ſame in other Rays; much more when we collect them into a Focus, they iſſue out without loſing their Colour; that which was red before it was united, is the ſame when it is ſeparated. Another Phænomenon in obſerving the difference of coloured Rays, is, that they ſuffer not the Refractions; they paſs not through the ſame Bodies; they are united in the Focus the one before the other, which is the cauſe of the imperfection of Teleſcopes.

It appears therefore evident that the Colours are formed by different Rays; thus the one can be extended on a Body when the others will be reflected, and conſequently the Objects can appear to us differently coloured; but when all the Rays are reflected, the Bodies will appear white; this is proved by the Reunion of all the Rays of the Priſm, in a Focus; in the Point where all the Rays are reunited, they form a very white Colour.

All theſe Rays, in dividing Objects, in penetrating them, and in falling on their Surface, follow Rules which we muſt know, to underſtand the uſe of the Eye; all the Parts of this Organ have been diſpoſed according to the Laws Light follows in its Motions; theſe are the principal.

The Rays, in proportion as they are diſtant from the Point whence they come, remove the one from the other; we may ſee this in receiving the Rays of the Sun through a Hole of a Window in a dark Room; theſe Rays form a Cone whoſe Point is at the Hole through which it enters; this is the Cauſe partly that we ſee but weakly diſtant Objects.

When the Rays fall on ſome Surface that oppoſes their Motion, they are reflected according to the ſame Laws as an Ivory Ball which falls on a Marble Table; but in Refractions different Laws follow; the ſenſible Bodies going from the Air obliquely into the Water, remove from the Perpendicular; but the contrary happens in the Rays of Light; when they fall obliquely from the Air in a more denſe Medium, they break in entring in that more denſe Medium, and approach the Perpendicular; but they are diſtanced, when they enter from a more denſe Medium into a more rare one.

To find out the Reaſon of this Phænomenon, we muſt obſerve, 1*ſt*, That the Air is compoſed of branchy Parts; thus Light muſt find more difficulty to move there than in denſe Bodies, whoſe Parts are thicker and more ſolid than thoſe of the Air; it is for this Reaſon that we have more trouble in walking in a Wood cut down than in a Foreſt where there are large Trees. 2*dly*, All Bodies that move obliquely towards a Plane, have two Directions in relation to that Plane; the one is a parallel Line to the Plane, the other a Perpendicular; the Body moves obliquely, follows a Line more or leſs near one of theſe two Directions; according to the Impulſe made by that Direction, when it finds a greater hindrance in one of theſe two Directions, they approach one another; but in the Point where the Rays fall between the Air and Water for example, they find a greater Difficulty to move in the Air than in the Water, as we have juſt proved; they muſt therefore turn and approach to the perpendicular Line in entring into the Water.

From theſe Principles it follows, that the Rays coming from a Body which is in the Air on a convex Glaſs, muſt be reunited in a certain Point; for the Ray of Light, which from the Object will paſs through the middle of the glaſſy Globe, will fall perpendicularly; thus having but this Direction it will continue its Way, without removing on either Side; but the Rays that fall at the Side, meet an oblique Plane; thus they muſt approach to the Perpendicular, and unite conſequently at a certain Diſtance; according as the Glaſs will be more or leſs convex, theſe Rays will be joined nigher or farther; if the Glaſs is ſpherical, they will be united in going from the fourth part of the Diameter; if it is elliptical, they will meet at the moſt diſtant Focus.

Before we apply what we have ſaid, it only remains for us to obſerve if the Rays fell on a Paper in the ſame Order that they part from an Object, they would paint that Object on the Paper. Experience alſo teaches us, that if through the Hole of a Window, we receive a

Ray on the Paper in a dark Room, the Objects whence the Rays part is painted on the Paper; but as the Rays are always removed, it happens that the Rays which come from one Point of one Object are mixed with thoſe which come from another Point. Thus the Image would be much more diſtinct if we could gather in one Place only all the Rays that part from the ſame Point of the Object; and this is done by the means of Glaſſes. I preſent, for example, an Arrow before a Glaſs; the Point of that Arrow will ſend Rays over all the Glaſs; that which falls perpendicularly paſſes without turning, but the others break in falling on the Glaſs, and are united at the Perpendicular. If the Point of the Dart is at the right Side of the Glaſs, its Rays will be united at the left Side; as for the Rays that will come from the other Extremities they will be united at the right Side of the Glaſs: If we let theſe Rays fall on Paper at the Point where they are united, the Image will be perfect, and we ſhall render it confuſed in approaching or in diſtancing the Glaſs.

By all we have been ſaying, we plainly ſee the Reaſon of what paſſes in our Eyes. The Globe of the Eye is a dark Room, where the Rays enter through the Holes of the Uvea, and where they are to be united in the ſame manner as when they paſſed through the Glaſs juſt now mentioned; thoſe that come on the right Side, are united to a Point at the bottom of the Eye at the left Side; thoſe that come from above, are united below, thoſe from below and from the left Side, are in the ſame manner united above and at the right Side; and hence it follows, that the Image of Objects muſt be turned upſide down in the Eye; but this cannot ſhew us the Objects thus placed. We bring back the parts of the Objects in the ſame Line through the which we have received their Rays; thus we bring back at the right Side the Impreſſion made at the left Side of the Eye; it is thus that a blind Man who keeps a Stick in his right Hand gropes the Objects which are at the left, carries them by the Impreſſion they make, on the right hand by means of the Stick.

The Images of Objects are painted at the Bottom of the Eye in the ſame manner as they are painted on the Paper, when we receive the Rays that enter through the Hole of a Window on a Lens. When the Rays fall on the aqueous Humour they bend, they fall obliquely on the Surface of the Cryſtalline, which is more denſe than the aqueous Humour, they muſt bend ſtill more, and approach one another in a perpendicular Line: they at laſt fall on the concave Surface of the vitreous Humour, which is leſs denſe than the Cryſtalline; they ought therefore to be diſtant from the perpendicular Line, and to bend ſtill in approaching one another. By this we ſee that *Boerhaave* is miſtaken, when he gives the vitreous Humour no other uſe but to facilitate the Motions of the Cryſtalline.

Theſe Rays thus bended unite at a greater or leſſer Diſtance, according to the convexity of the aqueous and cryſtalline Humour, or according to the diſtance of Objects. If the Cryſtalline is a portion of a Sphere where the Rays part, the Rays unite nearer to it. In a portion of a large Sphere, its Focus is found more diſtant. The Objects, according to their Diſtance, go from or approach the reunion of the Rays, the diſtant Objects ſend Rays leſs diverging than thoſe that unite ſooner.

Theſe two Phænomena give us the Reaſon why Old Men ſee not diſtinctly the Objects but when they are far from them; the Cryſtalline dries and flattens by Age; thus the Rays muſt unite on that ſide of the Retina. To obviate this Inconvenience, we muſt place the Objects at a greater Diſtance; then the Rays that terminate at the Cryſtalline, are united ſooner, as we have already ſaid; thus they can paint Objects on the Retina. We ſhall farther remedy this Inconvenience, in bending the Rays to diſpoſe them to unite; and this is done by the convex Glaſſes of Spectacles.

If the flattened Cryſtalline diſtances the re-union of the Rays, its Convexity approaches it too nigh, ſince it is a Portion of a very ſmall Sphere, and it is this that happens in thoſe who are ſhort-ſighted: the Rays gathered before they arrive at the Retina, can form there no Image; the farther the Objects are, the nigher will the re-union of theſe Rays be to the Cryſtalline, for the Rays are leſs diverging; we muſt then approach the Objects of the Eyes, ſo that the Rays that part from them may be united at a farther Diſtance; the concave Glaſſes will produce the ſame Effect, ſince they will remove the Rays in the ſame manner as if they came from a nigh Object.

By theſe Phænomena we ſee that the Soul perceives not the Objects, but on the occaſion of the diſtinct Image which is formed in the Eye; and hence it follows, that we can't clearly ſee Objects from far off; for the Angle the Rays that come from it forms is too ſmall, when the Diſtance is great; conſequently the Image of a large Body can be reduced to one ſingle Point, and hence will be confuſed; for if the Image of the Parts will be but one Point, their Rays will fall in one Point. To ſee therefore clearly theſe diſtant Objects we muſt diverge theſe Rays that fall in the ſame Point, and this the Teleſcopes do perfectly well in rendering the Rays divergent.

The difference of Angles which the Rays of diſtant and near Bodies form, gives the Reaſon of various Phænomena. 1*ſt*, Bodies far from the Eyes muſt ſeem to appear the one nigh the other, though there be a large Space enough between them; for this Space is repreſented in the Eye by an inſenſible Angle. 2*dly*, The Motion of diſtant Bodies cannot be perceived, for the Space run over being repreſented by an inſenſible Angle, we muſt not look on our ſelves as Parts of Space run over by a Body. 3*dly*, A very long Alley muſt ſeem to us more narrow at the End which is the moſt diſtant from us; for this End, which is the moſt diſtant from us, is repreſented in the Eye by a very ſmall Angle; by the ſame Reaſon, in a very long Room, the Plank muſt ſeem to us lower at the End, and two Towers near one another will ſeem nigher at the Top.

The Apple of the Eye may be larger or leſs; we may be convinced of this in looking on it in a Glaſs in the middle of the Day, and then in a weak Light. In the firſt Caſe we ſhall ſee the Hole very ſmall, and in the other its Diameter will be augmented by the Muſcles that are in Rays in the Uvea; hence it follows, that a Light muſt ſeem larger at Night than Day; the Sun muſt ſeem under a larger Diameter at its riſing than in the middle of the Day; a Tower at a diſtance ſeems ſmaller in the Morning than in the middle of the Day; at Night during a Fog the Objects muſt ſeem much larger, in proportion as the Light is more or leſs ſtronger; the Apple of the Eye ſtraitens or enlarges; when it is ſtraitened the Image of the Objects cannot be ſo extended but when its Diameter is larger. When we have been in a dark Place, the Eye cannot ſuffer a great Light, becauſe the Apple of the Eye which was extremely dilated, receives too great a Quantity of Light in open Day: to avoid the Impreſſion of a too ſtrong Light, we ſtraiten the Eye by the orbicular Muſcle which borders the Hole of the Uvea.

When an Object is in Motion, its Image moves on the Retina; for when it is at the right Side its Image is at the left, and on the contrary, *&c.* Thus when an Object advances from the right to the left, the Image muſt go from the left to the right. When we are on a Veſſel that is in Motion, the Images of Objects on a River move alſo; and as we perceive not that we are drawn by a Veſſel, they are the Objects of the Shore which appear to us to move: If the Retina was in Motion, the Objects, although they were immoveable, would ſeem to move, for by the Motion of the Retina the Image would change Places; and it is this that happens in the Head-ach; for the Artery that accompanies the Optick Nerve ſwelling, beats ſtrongly againſt the Optick Nerve and Retina. This pulſating makes the Parts of the Retina change place, and conſequently the Images of Objects fall on different Points.

Impreſſions made on the Retina remain a long while; and hence, when we move a Firebrand round, we perceive a Circle of Fire; the Impreſſion made by the Brand on one ſide, remains till it is returned there; but it is not to the duration of that Impreſſion that we muſt attribute the rowling of Objects to; that remains ſometimes a whole Day. After our being in a Ship, the Head-ach that attends ſometimes a Voyage, fills the Arteries of the Optick Nerve; as long as this fullneſs holds the Objects ſeem to move; but the Imagination which is accuſtomed to the Motion of the Ship, has always a part of it; the great moving Power that animates us, ſends the animal Spirits in the Nerves, according to the Impreſſions of Objects. When we are accuſtomed to a Motion, this Motion continues though our Will have no part in it; and not to leave our Example, when we deſcend from a Ship we can ſcarcely walk, becauſe we are accuſtomed to bend the Knee to walk in the Line of Direction during the Motion of the Ship; it is for the ſame Reaſon that we have an Head-ach when a Series of Objects has ſwiftly paſſed before us.

This ſwelling of Arteries of the Eye furniſhes us the explication of a Phenomenon on which there have been ſilly Diſputes: we ſometimes ſee black Points or kind of Flies, that hover before the Eyes, and hides from us a part of the Objects; it was believed that theſe Flies came but from the Spots of the Cryſtalline that lets not the Light paſs; but thoſe who have reaſoned thus, had no knowledge of Opticks. 1*ſt*, Objects nigh the Eye reunite their Rays beyond the Retina; they form not therefore there any Image, and thus they cannot be perceived; it is therefore impoſſible that we ſhould ſee the Spots of the Cryſtalline. 2*dly*, Theſe Spots hide from us, for Example, the Characters, when we read; but the Spots of the Cryſtalline could never produce that Effect; for a Character ſends Rays on all the Surface of the Cryſtalline; if ſome Rays are ſtopped by the Spots, there are others that paſs at the Side, and which paint the Character on the Retina.

tina. This is alſo conformable to Experience, that teaches us, that there have been Perſons who ſaw not theſe Flies, although one part of the Cryſtalline became thick. The true Reaſon of this Phænomenon is, that the Arteries being too much dilated in certain Parts of the Retina, hinder the Rays from falling on the Nerves, conſequently the Light that comes from a Point of the Object can make no Impreſſion. Thus we ſhall ſee nothing in that Point, *i. e.* there will appear a black Spot.

The Motion of the Retina, as we have juſt ſeen, makes us perceive a change in the Situation of the Object; but the Motion of the Axis of the Eyes cauſes another change, for it can ſhew us the Objects double or ſingle; when the Axes look to the ſame Point, then we bring the two Images that are in our Eyes to the ſame Place, we muſt then therefore ſee but one Object; but when the Axes are turned towards two different Points, then we ſee the ſame Object in two Places: When we are drunk, the Pulſations of the Arteries diſorder the Motions of the Eyes, in puſhing unequally the nervous Juice in the Muſcles; it is not ſurprizing therefore that we ſee many Objects.

The diſorder of the Humours change the Colours of Objects in the ſame manner as the diſorders of the Retina and Axis change their Situation; if they become yellow, the Objects will appear yellow. This is a Conſequence of what we have eſtabliſhed on the Subject of Colours. Yellow Glaſſes let the Rays paſs yellow, and tincture the others. This alteration of the Humours made ſome Philoſophers ſay, that it is poſſible for us to ſee all different Colours; but the Humours are almoſt the ſame in all Men; thus they muſt let paſs the ſame Rays: we may doubt if all Men ſee the ſame Colour, according to the Syſtem of thoſe who believed that Colours did not all depend on certain Rays; but when we ſuppoſe that certain Rays produce certain Colours, this Doubt muſt vaniſh, as we ſee in our Anſwer.

REMARKS *on the Saliva.*

The Parotid Glands, the Maxillary, Sublingual, and Almonds, appear to be compoſed of an infinite Number of Cellules, where the Fluid that runs from the Arteries is filtrated; the ſmall ſalivary Glands which are expanded through the Mouth, have certainly the ſame Structure.

The Fluid ſecreted in theſe Glands is very thin and tranſparent, without taſte or ſmell, does not thicken upon the Fire, changes into Froth when well lathered; when we faſt, it becomes ſharp and deterſive; it ferments the white Vegetables, Syrups, Bread, *&c.*

From theſe Properties we may eaſily deduce the Nature of this Fluid; it is, properly ſpeaking, a Soap well lathered; the Ducts which ſecrete it are extremely ſubtil; they let no groſs Matter eſcape, but that only which was extremely divided, *i. e.* this very attenuated oily Matter, mixed with Water by the means of Salts and motion of the Arteries, and, in a word, extremely rarefied; after it has been depoſed in the ſalivary Cellules, it is again lathered by the Motion of the neighbouring Arteries. All this being ſuppoſed, it follows, 1*ſt*, That the Saliva muſt be very much diluted and tranſparent, for the Diviſion and Mixture produce this Effect. 2*dly*, That it muſt be frothy, for as it is a little viſcous becauſe of its Oil, the

Air eaſily forms ſmall Globules there, which heaped together make a Froth. *3dly*, It muſt not thicken on the Fire; for the oily Parts being very much divided, they are eaſily raiſed when the Heat rarefies them, for then they become lighter than Air; whereas the Lymph, for example, has oily and thick Parts, that lets the Water eſcape at the firſt Heat, and then the oily Parts are preſſed ſtill more the one againſt the other by the Weight of the Atmoſphere. *4thly*, The Saliva has almoſt neither Taſte nor Smell, for its Salt is abſorbed in the oily Matter; but this is not ſo but in thoſe that are well, for in ſick Perſons heat alkaliſes the Salts, renders the Alkalies volatile, gives them a facility to ſeparate Acids, then the Saliva may have divers Taſtes; it will even produce different Effects that may diſtinguiſh an Acid or Alkaly. We muſt not therefore take for a Rule the chymical Operations which may be made on the Saliva; beſides that, the diſcompoſed Matters form before the Diſſolution a gathering very different from that, which it preſents to us when diſſolved; we have juſt ſeen the Alterations that Maladies may cauſe there. *5thly*, The Saliva in thoſe who faſt muſt be ſharp, and deterſive, and reſolutive; when the Heat alkalizes the Fluids of the Body, the Saliva then muſt contract ſome ſharpneſs. We know that Soap is a Compoſition of Salt and Oil. Thus it is not ſurprizing that the Saliva, which is formed of the ſame Principles, is deterſive; in ſhort, it ought to be reſolutive; for beſide that by its Action it open the Pores, it moves in the ſame time the Veſſels, and there cauſes the Fluids to flow by that agitation. *6thly*, The Saliva may contribute to Fermentation; for the Salts being volatilized may eaſily be looſened; thus they can then excite a Fermentation in the Body where Fluids will be found proper to diſcompoſe them. *7thly*, That which the Microſcope diſcovers to us in the Saliva is not contrary to what we have juſt eſtabliſhed; it ſhews us their branchy Parts that ſwim in the Water; theſe Ramifications are the Parts of Oil. *8thly*, In Maladies the taſte of the Saliva is bad; as the Humours are ſejourned and heated, they are alkaliſed, and conſequently the Saliva that comes from it muſt cauſe a diſagreeable Impreſſion: when we perceive no more bad taſte, it is a ſign that Health returns, for it proves the Fluids to flow, and not to be heated as before. *9thly*, The Saliva having a bad taſte, Aliments ſeem to us diſagreeable; this proceeds from their Parts mixing with thoſe of the Saliva. We ſee by theſe two laſt Articles the Reaſon why Phyſicians look ſo often upon the Tongue, and are ſo attentive to the Impreſſions ſick People feel there.

The Saliva with all theſe Properties was of an abſolute neceſſity. *1ſt*, There was a neceſſity for a Fluid that might moiſten the Mouth continually to facilitate Speech, and the Gullet to ſwallow down the Aliments, which without it could not ſlip down. *2dly*, A Fluid was neceſſary that might diſſolve the Salts and the oily Matters, which the Saliva by its aqueous Part, by its Salt and by its Oil can do; if it were entirely oily, it could not have diſſolved the ſaline Particles; and if it were but a pure Water, it would not have had an Ingreſs into the thick Matters. *3dly*, It was neceſſary that there flowed in the Mouth a Fluid which might mix the oily Matters, and thoſe that are aqueous; a ſaline and aqueous Fluid may do it perfectly, becauſe the Salt is united with thoſe two

Matters. *4thly*, If the Saliva had any Taſte or ſmell, it would have been impoſſible for us to have perceived any Taſte or Smell in our Aliments. *5thly*, Salts act not but when they are diſſolved; there was a Diſſolvent neceſſary that ſhould be always ready in the Mouth; the Saliva paſſes again in the Maſs of the Blood with the Aliments; and is always perfect to reproduce the ſame Effects.

The flowing of the Saliva augments or diminiſhes, according to the different Diſpoſition of the Body. *1ſt*, If we tie the Nerve which goes to a ſalivary Gland, the Filtration of the Saliva ceaſes not, but is performed ſlower. *2dly*, If we tie the jugular Veins of a Dog, the Saliva flows in ſo great a Quantity, that this flowing reſembles the Flux of the Mouth occaſioned by Mercury; this ariſes from the Blood's being ſtopped in the jugular Veins; the Arteries in the Glands that filtrate the Saliva are ſwelled, beat ſtronger, and by that means propel more Liquor into the ſalivary Filtres. *3dly*, At Night there flows leſs Saliva in the Mouth than by Day, becauſe during Sleep the Glands are not compreſſed by the Muſcles and Tongue, as they are when we wake; beſides, Tranſpiration that augments during Night, diminiſhes the Flux of the Saliva; it is for the ſame Reaſon that this Flux ceaſes during great Diarrhœa's. *4thly*, In certain Diſeaſes, as Melancholy, for example, the Saliva flows in great Quantity. This proceeds from the Blood's meeting Obſtacles in the meſenterick Veſſels, which are then ſwelled and filled with a blackiſh and thick Blood, as Diſſections demonſtrate, the Blood is thrown in a greater Quantity towards the ſuperior Parts; thus there are there filtrated more Fluids. This is confirmed by what happens after a ſpitting of

Blood, for then a great deal of Saliva flows; but we cannot ſay that this comes from Obſtacles which ſtop the Blood of one ſide, and make it flow in greater Quantities towards another, for ſpitting of Blood proceeds from nothing but ſome Obſtruction. *5thly*, In an Angina the Saliva flows in great Quantity, becauſe the Veſſels that go to the Glands are filled by reaſon of their Inflammation; thus they preſs out more Saliva. When the Jaw is diſlocated, we alſo ſee a great Quantity of Saliva, but it comes from nothing but that the Organs of Deglutition are diſordered; we cannot ſwallow the Saliva that is filtrated, thus it is thrown out; this Reaſon may be applied to the Angina. *6thly*, In the confluent Small-Pox there happens a great Spitting that proceeds from nothing but Tranſpiration being ſtopped, the ſalivary Glands receive more Saliva; as for the Spitting that happens in the growing Phthyſick, that ariſes from nothing but the Obſtacles which hinder the Blood from flowing freely; we have nothing to do but recall what happens through the Ligature of the jugular Veins, and we ſhall eaſily explain all the Phænomena of that kind.

A Salivation may be cauſed by Subſtances which we make uſe of: Tobacco, for example, occaſions a great Spitting; that which ſharp Purgatives produce in the Inteſtines, Tobacco produces too; it irritates the Nerves, ſtraitens the capillary Veſſels; all this cauſes as it were a choaking up of theſe Veſſels which propel the Saliva in the Strainers with greater force and in greater Quantity; in a word, Tobacco agitates as Veſicatories, whoſe Action we have explained.

The Matter that produces a Salivation in the greateſt Quantity is Mercury; the Difficulty that is preſented immediately, is, why this fluid Metal, which enters through the Pores of the Skin, diſpoſes the Fluids to flow through the ſalivary Glands. 1*ſt*, Although Mercury acts on the ſalivary Glands, it is not carried rather towards the Glands than towards the Inteſtines. 2*dly*, If Mercury is equally expanded every where, we muſt look in the ſole texture of ſalivary Glands, for the Reaſon by which this Fluid makes an Evacuation through theſe Glands. 3*dly*, The Texture of the ſalivary Glands can be forced more eaſily than that of other Strainers; thus Mercury dilates their Ducts; the little mercurial Parts that follow dilate them always more. This Dilatation being made, the Fluids are thrown in a greater Quantity into the dilated Places; thus there can there be formed a great Flux, while it is not performed in another; and this by the ſame Reaſon that Tranſpiration being extraordinary, the Belly is very much bound. 4*thly*, There is another Phænomenon in uſing of Mercury, and which we muſt attend to in explaining Salivation, *viz.* That there often ſucceed Swellings of the Head; but theſe Swellings happen not but through the Obſtructions that Mercury cauſes in the capillary Veſſels; theſe Obſtructions heap up the Blood, and the gathered Blood puſhes the Saliva ſtronger and in a greater Quantity into the ſecretory Ducts; this Reaſon joined to that mentioned, may ſerve to explain Salivation cauſed by Mercury.

In Diſeaſes the Saliva is vitiated. It is told in the Ephemerides of *Germany*, that an Old Man who had a Quartan Fever, put a little of his Saliva in the Mouth of a Child, and there immediately ſucceeded an Hick-up, an Inquietude, an extraordinary Heat, with very frequent

Sneezings. *Dolè* ſaw a ſcorbutick Man whoſe Saliva was very naſty and full of Worms. An *Engliſh* Phyſician ſaw a Woman who having neglected to let her Milk be ſucked from her, ſpit a milky Matter; and when this happened to the Woman, her Nipples unſwelled. Laſtly, In the Ephemerides of *Germany*, we ſee that a Man ſpit a Saliva that coagulated immediately, and formed a kind of Lime.

The Taſte.

Bellini is he who firſt gave us an exact Deſcription of the Tongue; that eminent Anatomiſt who joined to the Study of the human Body the Knowledge of geometrical Phyſick, ſhewed us immediately three kind of Eminencies on the Tongue. We ſee ſmall Pyramids, or rather Hairs pretty large at their Baſis, and are in the ſhape of Cones in Oxen; afterwards we find ſmall Papillæ like Muſhrooms, whoſe Neck is pretty ſtrait, and which we cannot better compare than to the Extremities of the Horns of Snails; in a word, there are flat Papillæ pierced by an infinite Number of Holes.

The ſmall Cones found in Oxen, or the ſmall Hairs found in Men, do not appear to be the Organs of Taſte; it is more likely that they are only ſubſervient to the Tongue, and only, if we may ſo ſay, to render it Briſtling, that the Aliments may fix there, and that by a Sweep of the Tongue we may cleanſe the Palate. Theſe Cones, which render the Tongue rough, were eſpecially neceſſary to Animals that graze, for the Herbs to fix there.

The Papillæ like unto Muſhrooms appear to be Glands, for there tranſudes a Liquor, when we preſs them; we muſt not therefore imagine that they are the Organs of Taſte.

It is more likely that it is in this kind of Cellules pierced with Holes that the Organ of Taſte is found, and agreeable or diſagreeable Impreſſions of the Aliments; for it is in the Cavity of theſe Cellules that the Extremities of the Nerves are found, and the Tongue is not ſenſible but in Places where the Papillæ are found pierced with many Holes.

There are many Reaſons to prove that theſe little fixed Nipples are the Organs of Taſte, the Hairs or little Pyramids are not ſenſible enough to ſhew us immediately the leaſt Impreſſions of Objects; in reality Experience teaches us, that if in Places where there are no pierced Papillæ, we put a Grain of Salt, we feel no Impreſſion; but if we put that Grain of Salt on the tip of the Tongue, where there are many little pierced Nipples, it will there excite a lively Senſation.

The Aliments act on our Organs only by their ſtiff Part, *i. e.* by their ſaline Parts; it is for this Reaſon neceſſary that they be diſſolved before they can act on our Tongue; for as we know the Salts act only when they are diſſolved, it is for this partly that Nature placed in our Mouths Springs of Saliva. Perhaps alſo through theſe Holes, which are at the Surface of the little Papillæ, of which we have been talking, there is filtrated ſome Liquor that diſſolves the Salts there applied.

As it was neceſſary that the Tongue ſhould have a great Senſibility, there alſo was a neceſſity of the Nerves eaſily receiving the Impreſſions of Objects; it is for this that the Nipples are pierced with Holes in which the Points of Salts diſſolved are inſinuated, and meet the Nerves which are naked under the Membrane pierced with the Papillæ; being puſhed againſt theſe Nerves by the Atmoſphere, they there excite a Senſation more or leſs lively according to the Figure, Maſs and Force, that puſhes them. But I ſhall be anſwered, why are theſe Salts puſhed by the Air into the Texture of the Nerves; the internal Air and Spring of the Parts are they not in equilibrium with the external Air? It is in theſe Vacua that the Salts are puſhed, and by the Motion impreſſed on them they vellicate the nervous Texture.

As Taſte depends on nothing but the Action of the Salts on the Nerves, we may ask, why we cannot tell the Taſte of theſe ſame Salts in the other Parts? But it is evident, that as ſoon as theſe Nerves will be differently ranged in ſome Part, the Impreſſions they will receive will be different; but in the human Body there is no Part where the Nerves are diſpoſed as in the Tongue; it is neceſſary therefore that Parts of Salts act there diverſly. This different Diſpoſition conſiſts partly in that the Nerves are very viſible in the Tongue, and more naked than in almoſt all the other Parts. But all this we have been ſaying muſt not make us believe that the Tongue is the only Part ſenſible of Taſte. It is reported in the Ephemerides of *Germany*, that an Infant whoſe Tongue was putrified in the Small Pox, ſpoke and taſted his Aliments very well. We ſhall not be ſurprized at that, if we reflect that at the Palate, Almonds, and internal Part of the Cheek towards the Concourſe of the Dentes Molares of the two Jaws, there are nervous Organs like thoſe of the Tongue, and conſequently are moved in the ſame manner by the Action of the Salts.

The different Senſations excited on the Tongue, depend on the different Figures of the Body; the Matters that have very pointy and cutting Parts, will make a very lively Impreſſion; but thoſe whoſe Parts have nothing but very ſmall Points, will do nothing but tickle the Tongue; in a word, the Parts that have a Surface ſmooth and poliſhed, can make no Impreſſion there; for example, the Acid of Vinegar is felt very lively at the Tongue and the Nerves; but if we unite it with Lead, it forms with it a Compoſition of a ſweet Taſte as that of Sugar. The Spirit of Nitre which we may call a true Fire, and is ſo cauſtick, is no more corroſive when it is mixed with the Spirit of Wine; it then gives a ſweet and aromatick Fluid; they are the oily Parts of the Spirit of Wine that involve the Acid, and hinder it from acting ſo ſtrongly. *Terreſtrial Subſtances* mixed with an Acid, give an auſtere Taſte, and if they are predominant the Taſte will be ſour: the more Salt Alkaly is purer, the more it becomes ſharp; the vitriolick Salt joined to the Baſis of Marine Salt, Tartar, Salt-petre, compoſes a bitter Salt: As for the earthy and aqueous Matters they are inſipid, as Oils deprived of their Salts. We may produce all theſe Taſtes by an infinite Number of other Mixtures, but we cannot make general Rules thereupon, we know not well enough for this the Mixtures of Bodies; beſides, we muſt not doubt but the Matter of Fire that is expanded over all, contributes not much to vary the Savours, witneſs the alkaline Salts, which become always more cauſtick in proportion as they are expoſed to the Fire.

All theſe Senſations we prove, differ not either by too much or too little; thus Pleaſure is but the beginning of Pain; a ſoft tickling cauſes Pleaſure, it occaſions but a light Motion in the Nerves; but if it augments, it may tear the nervous Fibres; hence we ſee, Matters that have a very lively Taſte, may give painful Impreſſions.

When we faint there are Aliments whoſe agreeable and lively Taſte gives us immediately new Force; this comes from their ſubtile Parts acting immediately on the Nerves, and there make the nervous Juice flow; but we muſt not believe that this Agitation in the Nerves of the Tongue can alone produce ſuch an Effect. Theſe ſubtil Parts of which we ſpeak, are immediately inſinuated in the Veſſels, agitate them by their Action, and are carried to the Brain where they move the Principal, the Nerves; all this occaſions the Motion of the nervous Juice that was before almoſt immoveable in our Machine.

REMARKS *on the Noſe and Senſe of Smelling.*

We have in Oſteology ſeen the Deſcription of the ſpongious Lamina, the Oſſa Turbinata, and the Cellules of the Os Ethmoides; in certain Animals theſe Bones have more extent than in the others; in Hares, for example, the Oſſa Turbinata form many Pleats; in a word, the more Animals have a quick Smell, the more conſiderable are the Turbinata.

All theſe Bones of the Noſe are inveſted with a Membrane which is inſinuated into the Cellules and Sinus's it meets; through all theſe Pleats it has a great Extent; although the Space of the Noſtrils is not very large; it is accompanied with an infinite Number of Veſſels that depoſite the Humour they filtre in ſmall Lacunæ.

Through the Holes of the Os Ethmoides deſcend nervous Filaments from the Brain, which after having penetrated the Coverings of the Dura Mater, furniſhes them with and follow all the Pleats; in no Part of the Body do Nerves meet one another ſo plain and ſo delicate.

The firſt Uſe obſerved in this Membrane is the filtration of a Fluid without Taſte and Smell, but which mixes eaſily with Water, changes into a kind of Lime when dried, and renders the internal Surface of the Noſe very ſlippery.

The oily Subſtance being well mixed with Water by the Motion of the Veſſels, is depoſited in great Quantity into the Filtres of the pituitary Membrane; but as it is not ſo well mixed with Water, nor ſo well divided as the Saliva, the Heat raiſes more eaſily the aqueous Parts, and then the oily Parts being dried can form a chalky Subſtance.

This Fluid flows in great Quantity when we have a Cold; for when we are taken with a Cold, the Veſſels that are expanded from the Head are very much ſtraitened; Tranſpiration ceaſes there; thus the Matter which flows in the Veſſels that go to the Head is obliged to flow in larger Quantity towards the Noſe; then there happens a ſmall Inflammation at the pituitary Membrane, the Quantity of Blood, the Swelling of the Veſſels, is the occaſion of the Humours filtrating in greater Quantity. M. *Keil* makes an Objection againſt this in his Treatiſe of Tranſpiration; he ſays, that Tranſpiration diminiſhes ſometimes more than when we have a Cold, without producing any Diſorder; but this proves nothing againſt that which we have ſaid: when we uſe Aliments that ſtop Tranſpiration, all the Filtres are found equally ſtraitened; the ſame thing happens according to the divers Circumſtances that accompany other Cauſes which diminiſh Tranſpiration; but in the Caſe we are upon, the external Veſſels of the Head are found all at once ſtraitened, whilſt the Heat in the internal Parts hinders the like ſtraitening.

As a Cold occaſions a flowing at the Noſe, the exceſſive Heat cauſes the ſame alſo; the external Parts of the Head being very much rarefied by the Heat, the Blood is carried there in greater Quantity, and fills the Veſſels; this fullneſs forms an Obſtacle to the Blood that follows, which is then forced to be thrown in a greater Quantity into the Arteries of the pituitary Membrane: but we muſt obſerve that this Flux happens, eſpecially if we uncover ourſelves in a cold Place, when we are hot; then the ſudden ſtraitning that follows in the full Veſſels fills them more, and the Blood that remained on one Side is thrown more abundantly into another.

As ſoon as the Flux ceaſes, we wipe the Noſe with difficulty; this proceeds from the Membranes that were relaxed during this Flux, retaining the Mucoſity in their Pleats, when it flows not in ſo great a Quantity; during this the aqueous Part is exhaled, and a thick Matter that ſtops the Noſe when it runs down remains.

When we uſe ſome ſharp or ſubtil Powder, it makes the Mucus of the Noſe flow; becauſe ſome Parts of the Snuff applied to the Nerves, and the Irritation they produce ſtops the Blood in the Veſſels of the pituitary Membrane, and preſſes out of it a larger Quantity of Humour; in a word, Powders that occaſion Sneezing act as Purgatives whoſe Actions we have explained.

When we ſneeze, there flows alſo a great deal of Mucus from the pituitary Membrane; we muſt attribute it to the Cauſe we have mentioned; then we muſt obſerve the Nerves that ſerve Inſpiration being agitated, as we have obſerved in ſpeaking of ſneezing, they agitate in their Turn thoſe that agitated them, *i. e.* thoſe that are expanded in the pituitary Membrane, with which they communicate; this Agitation ſtifles the Veſſels of that Membrane, and preſs out the Mucus; then the preſſed Humour being deſcended, the Air that iſſues out with great impetus in Expiration takes away what it meets with.

The ancient Phyſicians, and many even among the Moderns, believed that the Pituita came from the Brain, but there is no Paſſage from the Brain into the Noſe: thoſe that imagined that the pituitary Gland, which is on the ſphenoidal Saddle, was diſcharged into the Noſe, knew not that Liquids we inject into that Gland run into the jugular Veins; as for the Holes of the Cribriform Bone, it is impoſſible the Pituita ſhould paſs there; theſe Holes give Paſſage only to the Nerves and ſmall Veſſels that accompany theſe Nerves; it is through theſe ſmall Veſſels that the Blood may ſometimes come from the Brain in Hemorrhages.

This Humour of which we have been ſpeaking was of an abſolute neceſſity; it ſtops in Inſpiration the groſs Matters with which the Air was loaded, and which might trouble the Lungs; it defends the olfactory Nerves from too ſharp Matters, hinders them from being dried in moiſtening them; thus theſe Nerves that are naked and expoſed to the Injuries of the Air, preſerve even in an advanced Age a lively Senſation in the pituitary Membrane.

If the pituitary Membrane receives the ſanguinary Veſſels to filtrate the Mucus, it receives the olfactory Nerves, that we may perceive the nature of Corpuſcles which are continually raiſed from Objects; theſe Corpuſcles may hurt or be uſeful to us; thus it was, *a propos*, that the Soul could receive their Impreſſion; it is for this that Nature ſent to the pituitary Membrane the Ramifications of the olfactory Nerves, which being entirely diſcovered are very eaſily agitated.

The groſs Bodies may make Impreſſions on the olfactory Nerves, but by their Action we perceive not that which we call *Smell*; we perceive nothing but a diſagreeable Impreſſion, when they are applied to theſe Nerves; the Matter which occaſions Smell is very ſubtil, and that which is found in Aromaticks is, according to ſome Authors, different from all the Matters that we know; after it has exhaled, we perceive no diminution in the Body from which it iſſues; there is but an infinitely ſmall Quantity neceſſary to communicate the Smell to a great Maſs of other Matter; but notwithſtanding all this, we may ſay that the Parts of odoriferous Bodies are very attenuated Salts joined to volatilized Salts: By their Diviſion theſe Salts, and theſe oily Parts have been reduced into Maſſes, whoſe Surfaces are very conſiderable; when their Weight is reduced almoſt to nothing, they may therefore be ſuſtained by the Air, and carried from one Side to the other; for example, in Viands that rot the alkaline and volatile Part ſeparated from its Acid is raiſed, the Acid volatiliſes alſo as the Alkali, by the union of the oily Parts: we have an example in the ſulphureous Spirit of Vitriol; theſe two Salts differently combined may occaſion an infinite Number of different Impreſſions.

We have juſt ſaid, that the Corpuſcles which occaſion Smell, are of no other Natures than the Bodies from which they go out; theſe are Proofs of it. 1*ſt*, The Corpuſcles that are exhaled from Wormwood occaſion on the Tongue the ſame Impreſſions as the Wormwood itſelf. *Boyle*, who gives us this Obſervation, ſays the ſame thing of Amber diſſolved in Spirit of Wine. 2*dly*, The ſame Author has again obſerved, that one of his Friends having beat ſome black Hellebore in a Mortar, all thoſe that were preſent in the Chamber were purged. *Sennert* made the ſame Obſervation on the Coloquinte. 3*dly*, When we diſtil ſomniferous Subſtances, we often fall into a ſound Sleep, and there is an Author who tells us, that he was very drowſy by what run from the Seed of Mandrakes, which he preſerved in his Cabinet. 4*thly*, It is ſaid many People have lived ſome time by the Smell only of certain Aliments; I mention not *Democritus*, whoſe Siſter kept him alive during three Days by the Smell only of Wine thrown upon freſh Bread. Chancellor *Bacon*, whoſe Word is much more worthy of Belief than of the Book we juſt now mentioned this Fact from, ſays, a Man lived four Days ſuſtained by the Smell only of ſome Herbs mixed with Garlick and Onions. All theſe Examples demonſtrate that the moſt part of odoriferous Corpuſcles are of the ſame nature as thoſe Bodies they come from, for they produce the ſame Effect.

That the Corpuſcles which are exhaled may make an Impreſſion on the olfactory Nerves, it is neceſſary they be carried there with Force;

for we ſee that if we retain Reſpiration, we ſcarce perceive the moſt penetrating Odours; as the pituitary Membrane is always covered with a Humour that ſtops the Fluids which come outwardly, we ſee it can offer ſome reſiſtance to odoriferous Corpuſcles, for it ſtops the Holes through which they may be inſinuated into the Subſtance of the Nerves, and for this Reaſon after we have a Cold we perceive no Smell; the thick Matter on the Membrane hinders the Corpuſcles from going as far as the Nerves; but when we inſpire, theſe Corpuſcles puſh ſtrongly againſt the olfactory Nerves, and enter in great Quantity; hence it follows, that in Expiration the ſtrongeſt Smells ſhould make no Impreſſions on the Noſe; for then the Corpuſcles not only are carried with force againſt the pituitary Membrane, but they are repulſed by the Air which comes from the Lungs.

The odoriferous Corpuſcles act on the Noſe as ſavorous Bodies act on the Tongue; the difference between the Action of the one and the other is in part becauſe the Corpuſcles which occaſion the Smell are much more ſubtil than thoſe that cauſe in us the Senſation we call Taſte; thus they ſhake the Nerves of the Noſe, which are the moſt delicate, and make no Impreſſion on the Tongue.

We are ſtrengthened by the odoriferous Bodies, becauſe the Parts in moving the olfactory Nerves move thoſe that communicate with them, and cauſe the nervous Juice to flow there; beſides, they enter in the ſanguinary Veſſels on which they act, and in which conſequently they make the Fluids flow more rapidly: All this revives us after a fainting Fit, ſince they conſiſt but in a Ceſſation of Motion; but if this Agitation cauſed by the odoriferous Bodies were extraordinary, it might carry the Convulſions into the Parts whoſe Nerves communicate with thoſe of the Noſe; theſe too violent Convulſions may at laſt cauſe Death, and this has happened ſometimes by the uſe of Hellebore.

The olfactory Nerves are leſs ſenſible in ſome than in others; thus the ſame Corpuſcles may make very different Impreſſions; hence Smells which are not ſenſible to certain Perſons produce in others ſurprizing Effects. We ſee *v. g.* that in the hyſterick Diſeaſe Women come to themſelves by the Force of certain diſagreeable and very penetrating Odours, whereas agreeable ones increaſe their Diſeaſe; this is the Reaſon of it; ſtrong Odours ſhake the Nerves that communicate with the Olfactory, and make much nervous Juice flow equally every where; becauſe of this inequality of Juice that gives Action to all the Body, one Part will not carry it over the other; thus there will be no Convulſion; but agreeable Odours are all ſomniferous; thus they ſtop a little the run of the nervous Juice, and muſt conſequently produce an Effect oppoſite to that of ſtrong Smells, if it be not perhaps that they are ſomniferous enough to extinguiſh Action every where, and it is for this Reaſon that Opium ſucceeds in theſe Maladies.

As there are many Windings in the pituitary Membrane, and that there is there always found ſome Mucus, the thick Parts which will be there carried may be ſtopped here a long time, for which Reaſons the Corpuſcles which are exhaled from the Animals or putrified Vegetables, make an Impreſſion that ſtays a long time; we have need to take much Sternutatories to diſſipate theſe Corpuſcles; the Agitation that follows then the pituitary Membrane, and the Humour which flows in greater Quantity, takes away theſe diſagreeable Corpuſcles: but after Sneezing if ſuch Odours were carried to the Noſe, they would make a greater Impreſſion, as we obſerve in the Morning when we riſe; then a thick Humour covers the pituitary Membrane, becauſe the Heat has evaporated the aqueous Part, and left the thicker Matter, which cannot be removed away during the repoſe of the Night; this viſcous Humour ſtops the odoriferous Corpuſcles; but when we have rejected it by the force of Sneezing, the Nerves are found free and full of nervous Juice, they will then be more ſenſible than before.

From the great ſenſibility of the Nerves of the pituitary Membrane; it follows, 1*ſt*, That if we paſs over ſome Fæces it muſt there excite a great ſenſation. 2*dly*, That ſtrong Smells are Sternutatories, for in ſhaking ſtrongly the olfactory Nerves, they ſhake the Nerves which are ſubſervient to Reſpiration, and communicate with them. 3*dly*, That Animals where the pituitary Membrane will be very much extended, will have a ſubtil Smell, and this is ſo in Hounds.

REMARKS *on the Ear.*

The external Ear is like the broad end of a Trumpet; at its bottom there is formed a cartilaginous and membranous Duct that goes from behind forwards, and is made crooked to enter into the bony Orifice.

This Duct is terminated by a Membrane that covers a Cavity which forms a kind of Drum; this Membrane is compoſed of three Laminæ, that of the middle has many Veſſels,

but

but the internal and external are a continuation of the Epidermis on each Side; the middle of that Membrane is hollow as the bottom of a Bottle.

The Anvil has two Branches that form a kind of right Angle; there is one that fixes poſteriourly at top to the brim of the Cavity; the other Branch deſcends the length of the Membrane now mentioned, and falls perpendicularly on the Head of the Stapes to which it is joined by the means of a little bony Globe; as for the Baſe of the Stapes it ſhuts the Feneſtra Ovalis, at the Side of which it is joined by a Membrane that permits the Baſis to remove a little when the pyramidal Muſcle acts, or when the Head of the Incus is puſhed upwards by the Malleolus, the Head of the Malleolus is placed on the ſolid part of the Incus, that has two Cavities and one Eminence to receive this Head, but the Handle is applied and fixed to the Membrane as a Supporter, which puſhes it outward when it is raiſed.

The Cavity communicates with the Mouth by a Canal called Tuba Euſtachiana, and with the Cellules of the Maſtoide Apophyſis poſteriourly; in its bottom there are two Holes, the one which is inferior, is called Feneſtra Rotunda, the other which is ſuperior, is called Feneſtra Ovalis, that leads to a Cavity called Veſtibulum; behind that Cavity are the three ſemicircular Canals, of which two have but one Opening, which anſwers to the Veſtibulum the ſame as the others; at the anterior part of the Veſtibulum is found a Shell forming as it were two Spires, which make two Windings and an half, the one anſwers to the Feneſtra Rotunda, and the other to the Veſtibulum; theſe two Spires make properly ſpeaking but one, which is in form of a Spiral; it is not large enough to divide the Spire, and one Membrane finiſhes this Diviſion.

All the Parts of the Labyrinth receive the nervous Filaments of the Portio Mollis that is divided into three Ramifications; the one enters by the Baſe of the Concha, and throws in advancing towards the Point an infinite Number of nervous Filaments in the form of a Ray, the other two go to the Veſtibulum and ſemicircular Canals.

The uſe of the Parts we have juſt deſcribed was always very difficult to be determined; the new Diſcoveries augmented the Difficulty, ſince they ſhewed us an Organ ſo compoſed, as to require a long time to know its Windings.

The Antients knew nothing of the Structure of the Ear, thus they can teach us nothing on its uſe. *Veſalius*, who dived deeper than his Predeceſſors, began to ſhew us this admirable Machine, but he left a great many Enquiries to be made; he believed in general that the Ear was as a muſical Inſtrument. *Fallopius* only left us a Promiſe, which he never fulfilled. We know not the Opinion of *Colombus*, he himſelf knew it not, ſince in the time he ſhould have gone from the firſt to the ſeventh Book, he forgot what he had advanced, for he very formally contradicts himſelf.

Euſtachius believed that the internal Air agitated by the Bones, carried its Agitation on the Nerve. *Picholomini* had a ſingular Opinion; he ſaid, that there was a Veſicle full of Air, and fixed to the Stapes. The Nerves, according to his way of thinking, bend at this Veſicle, which being agitated by the ſmall Bones, tranſmits its Agitation to the Nerves in the ſame manner as the Cryſtalline tranſmits the Rays at the bottom of the Eye. *Aquapendens* imagined that the little Bones carry'd their Agitation in the internal Air after the ſame manner as a Beam ſtruck at one end carries the Blow to the other. The Feneſtra Rotunda, as he believes, was ſubſervient to a deep Baſe, and the Ovalis to a ſharp Sound. There is no other uſe for the Concha and Labyrinth than to hinder the Reflections of Sound. *Caſſerius* denied that there was an internal Air, and ſubſtituted in its ſtead a Nerve. All the antient Authors followed ſuch Opinions, which merit not to be confuted.

When two Strings of an Inſtrument are at the Uniſon, if we ſtrike the one the other reſounds alſo. This Experiment gave room to ſeek in the Ear ſome Organ which had Parts that might be at the Uniſon with all the ſonorous Bodies. Let us imagine a very conick Clock divided into many Circles perpendicular to its Axis, the largeſt Circle will have a very grave Tone, and the ſmalleſt will have a very ſharp one. If we could find a little Machine in the Ear, we ſhould have many Cords which might be at the Uniſon with all theſe ſonorous Bodies, but this is found ſo in the ſpiral Lamina which is in the Concha; but this Reaſoning has no more Foundation than the others; there is no Concha in Birds, nor in Fiſh, nevertheleſs they perfectly hear all Sounds; as for the bony Canals it would be ridiculous to think, as a modern Author has done, that by their greater or leſſer Parts they were at the Uniſon with ſonorous Bodies: the Sides of theſe Canals are by their hardneſs and thickneſs incapable of Vibrations, that are excited in a Chord by the Action of another which is at the Uniſon with it. If this Notion took place, I might ſuſtain that a Beam differently configurated muſt reſound, when we play upon any Inſtrument near it. In order to determine the uſe of the Parts of the Ear, we muſt ſpeak of ſome Properties of Sound in the ſame manner as we have ſpoken of the Properties of Light to explain Sight.

Sound conſiſts in the Vibrations of the Air, as every Body knows; when we ſtrike a Clock, for example, the Parts ſtruck are bent; by this Reflection they are diſtanced one from the other in certain Points; this Diſtance muſt neceſſarily make the Parts of the Air recoil; theſe Parts in recoiling are compreſſed; after being compreſſed they are looſened; and it is this diſbanding which ſtriking the Ear produces ſound.

When the Parts of the Air are looſened, they act on all Sides; but when they are looſened towards the Side they meet ſome ſolid Body to which they cannot tranſmit their Motion, they return, and cauſe what we call an Eccho: But for this it is neceſſary that the ſonorous Rays fall on a concave Surface, then they are all reflected towards a Point in the ſame State that they are parted from the ſonorous Body; but if they fell on a Surface, and are divided ſtill in returning, they make no Impreſſions on the Ear. We ſee by all this that we cannot have Eccho but in a Point, *i. e.* in a Place where the Rays are united.

The ſonorous Rays which are converging into a Point, muſt have much more force than when they are divergent. Let us ſuppoſe that when a Man ſpeaks, the Noiſe heard at an hundred Feet diſtance is as the thouſandth part of a Report of a Cannon; if there were a thouſand Men about the Man that ſpoke, the ſonorous Rays which go to theſe thouſand Men would be a Noiſe equal to that of the Cannon, if they were reunited; it is this reunion that is made when we ſpeak through a Speaking Trumpet, or through crooked Tubes.

What I have ſaid on the Power of reunited Rays, appears ſenſibly by the following Experiment: Take a conick Duct, whoſe broad End is very open; turn the Baſis of the Cone towards ſome neighbouring Place where People are talking, and apply that ſmall Orifice to the Window, you will hear what they ſay although they whiſper; the large Orifice heaps together many ſonorous Rays, and reunites them in a ſmall Quantity; it is therefore neceſſary that they make a greater Impreſſion than if they were divergent.

By what we have ſaid, we ſee that the Conchæ are very proper to augment the Sound, for the ſonorous Rays unite in a Point. *Dionyſius*, the Tyrant of *Syracuſe*, cauſed a Priſon to be built in a Rock in ſhape of a Snail; at the Point was a Chamber for the Jailer, who by that means could hear what all the Priſoners ſaid. This Grotto is ſtill extant; we cannot ſneeze there, without making a Noiſe like that of Thunder.

The crooked Ducts augment alſo the Sound to a very great degree. This augmentation is produced by the ſonorous Rays which reunite, but it depends alſo on another Cauſe. We know that if we place ſeveral Balls in the ſame Line, and puſh this Line of Balls, in giving it a blow with a Hammer at the End, the laſt only is moved, and has a more conſiderable ſwiftneſs than the firſt Ball, had it been alone. I ſhall not here explain this Phænomenon; it is ſufficient we know that the more Balls there are the more Swiftneſs will the laſt have.

If we diſpoſed the Balls in curve Lines between two elaſtick Plains in ſuch a manner, that the Angles were all equal; thus the laſt would have more Motion; but what we ſay of the Bowls, which muſt be looked on as ſo many elaſtick Circles, may be explained by the ſonorous Rays which paſs in a curved Tube. Let us ſuppoſe that the Parts of the Air, which we may conſider as ſo many bent Bows, form a hundred Lines that go from one Side of a Tube to the other, it is certain that if the Vibrations are communicated in curved Lines, they will paſs through many more Particles of Air; all, in a word, will be like that which happens to the Balls diſpoſed in curved Lines. Thus the Motion will be much greater in the Parts of Air of a crooked Tube, for it is evident that there muſt be a greater Reflection there.

What we have juſt ſaid will diſcover to us the uſe of the Parts that compoſe the Ear. At firſt there appears outwardly a kind of Funnel, which is deſtined to receive a great Number of Rays, and reunite them. Experience teaches us, that thoſe who have no external Ear have not their Hearing as well as before they loſt that Part. I ſhall look over the Differences there are between the external Ear of a Man and that of Animals. This will lead me too far; but if the Funnel we were ſpeaking of is wanting in ſome Animals, there is always ſomething that makes a Compenſation, or rather, it is not neceſſary for their Conſervation that their Hearing be very good.

The external Duct is cartilaginous; it is therefore formed of a hard Subſtance, ſo that it might reflect the Sound; it goes not in a ſtrait Line. Through theſe windings Nature would augment the force of Sound; for we have proved that curved Ducts give force to the ſonorous Rays; in ſhort, it is inſerted obliquely, and in this Nature ſhews us a wonderful Artifice; for when we are in the middle of a Room covered with a round Roof, if we throw an Apple on any Side, it always rebounds in the middle, but if we alſo place ourſelves in a corner of the Room, the Apple we ſhall throw againſt the Roof will always rebound to the other oppoſite Corner. We may ſay the ſame thing of the Ear. If the external Duct placed in a right Line and perpendicularly on the Tympanum, the ſonorous Rays puſh againſt the elliptick ſuperior part of the Tympanum; thus they muſt return on the inferior, *i. e.* towards the Place where are the Feneſtra Ovalis and Rotunda.

There is a Membrane that terminates the external Duct of the Ear. There have been Authors who believed that according to the various Degrees of Tenſion that it might have, it was at Uniſon with ſonorous Bodies, but this is not neceſſary; Tunes paſs acroſs very lax Bodies; it contributes nothing to the Hearing; it was found broke or pierced in divers Animals, without the Ear's ſuffering any thing by it; all the uſe it has is to hinder any thing, being inſinuated into the Cavity of the Drum, which being covered with a very ſenſible Perioſteum, and open by a large Number of ſmall arterial Ramifications, the cold Humidity would have produced Diſorder in this Cavity, and would have extinguiſhed Sound.

The Membrane we have mentioned covers an elliptick Cavity, on which it is placed obliquely in approaching towards the Baſis of the Axis of the Body; hence we ſee that the ſuperior part of the Cavity is larger than the inferior, and it is this facilitates wonderfully the Reflection of Rays towards the inferior part, *i. e.* towards the Feneſtræ.

In the Cavity of the Drum againſt the Membrane we find the three little Bones we have deſcribed; let us now ſee the uſe of the Malleus. We muſt conſider this Bone as the Leg and Thigh ſtiffly extended, and making an obtuſe Angle when we ſit; the Head of the Femur is as the Head of the Hammer articulated, which is placed againſt the Membrane: it is certain that if we put our Hand near the Knee, and raiſe the Thigh and Leg, we might puſh any thing away with our Leg. This illuſtrates how the Cafferian Muſcle acts that comes from above; it raiſes the Leg of the Malleus, and puſhes the Membrane outwardly. As this Membrane is ſunk in the Tympanum, it is then neceſſary that it ſhould be more lax when this Muſcle acts; not to leave our Example of the Leg and Thigh, if from under the Chair there came a Cord which were fixed near the Knee; this Cord would draw the Leg againſt the Chair. This is done by the Euſtachian Muſcle, which ariſes from the internal part of the Tube, paſſes through a Ring near the Feneſtra Ovalis, and thus from the bottom of the Tympanum, and fixed to the Manubrium of the Malleus towards the Inſertion of the external Muſcle which we have been ſpeaking; it draws therefore the Membrane towards the bottom of the Drum, *i. e.* it gives it Tenſion. There is another Muſcle fixed to the ſmall Apophyſis, which is confounded almoſt with the Precedent at its Origin, but it runs through the external part of the Euſtachian Tube, and is fixed to the ſmall Apophyſis of the Malleus; it brings back the

Malleus, and the Membrane of the Tympanum towards the auditory Duct.

As the Membrane is not the Organ of Hearing, it is evident that the Malleus and Muſcles that ſerve to move it, cannot be the Organ of Hearing; but if this Membrane were very much extended, the great Noiſe would have burſt it, therefore according to the force of Vibrations of the Air this Membrane can be relaxed; beſides, the Sounds are communicated more eaſily by an extended Matter, and in part are loſt in a lax one; thus, that we might hear very low Sounds, and diminiſh too acute ones, it was neceſſary that the Membrane of the Tympanum might have divers Degrees of Tenſion.

The Incus ſerves in ſome meaſure to ſupport the Malleus. Thus we may ſay that in this it contributes not to Hearing, but it is fixed to the Head of the Stapes by the means of a little bony Globe. Let us ſee what uſe the Stapes has in Hearing, and then we may judge of the uſe of the Anvil.

The Stapes is placed perpendicularly on the Feneſtra Ovalis, which it ſtops with its Baſis; the edges of this Baſis are fixed to the Borders of the Feneſtra Ovalis by a Membrane which yields when we bend the Stapes by the Point, or puſh it forward; for which Reaſon Nature placed poſteriorly at the Feneſtra Ovalis a ſmall Muſcle in a kind of Grotto, from which goes out its Tendon, by the Axis of a ſmall bony Pyramid, and fixes at the Head of the Stapes. By this Muſcle the Stapes is raiſed at the anterior part of the Feneſtra Ovalis in the ſame manner as the Point of the Foot when we raiſe it above the paved Stone; beſides this, the Baſe, which is extreamly thin, is pierced with an infinite

Number of ſmall Holes, according to the Obſervation of *Manfredi*; all this was neceſſary, ſo that the Vibrations of the Air might paſs in the Veſtibulum; but hence we ſee that the Stapes contributes nothing to Hearing, it only moderates the force of Vibrations of the Air in ſhutting and opening the Paſſage more or leſs: as for the Incus it ſupports the Head of the Stapes, and brings it back by the Spring of its inferior Branch, when it was drawn backwards. Thus Hearing might ſubſiſt, though even the Incus were wanting.

At the anterior Part there is a Canal partly bony and partly cartilaginous and membranous; it is terminated on the Cover of the Palate laterally by a kind of a * Cuſhion that ſtraitens the Orifice. This Canal was of an abſolute neceſſity in relation to the Motion of the Membrane of the Tympanum; for if the Air could not enter through that Tube, the Membrane could never be puſhed outwards; for this Membrane in advancing outwardly might have left an empty Space, and thus might have overcome the Weight of the Atmoſphere: the Cafferian Muſcle would not have had Force enough to produce this Effect. Hence we ſee that it is without Foundation that an Author ſaid that the Air retires in the Maſtoide Cellules, when the Membrane of the Tympanum is extended, and that it goes out when it has been relaxed; all this is falſe, the Air goes out and enters through the Euſtachian Tubes. As for the Maſtoide Cellules, they appear to me not to have any other uſe than to moiſten the Drum by the Humidity filtrated there; perhaps they ſerve alſo to break the force of Sound. Formerly a Problem was propoſed, *viz.* How it is poſſible that in the time at which we retain with Force the inſpired Air, that the Tympanum ſhould be inflated, for it appears not then that the Air may enter through the Tubes; we muſt obſerve, that then we ſhut the Paſſage of the Air through the Noſe in raiſing the Cover of the Palate; the Cover cannot be ſtrongly made, but the Extremity of the Tube muſt be compreſſed, and the Air which was in that Extremity paſſes into the Ear.

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* Note, *It is a Pudding that is put round the Child's Head, that if it falls it may not hurt itſelf.*

At the bottom of the Drum we find the two Foramina of which we have been ſpeaking; they are found placed in ſuch a manner, as we have already obſerved, that the ſonorous Rays are there united; the Vibrations of the Air are communicated through the Membranes that cover theſe Holes at the Air of the Veſtibulum. The exiſtence of this Air in the Veſtibulum is demonſtrated, ſince it is evident that the Baſis of the Stapes and the Membrane that covers the Feneſtra Rotunda would be broke by the Power of the external Air: if there was no Air to counterbalance this Power, it is not difficult to conceive how this Air is diſcharged into the Veſtibulum; as ſoon as there is an empty Cavity, the Air which is in the Fluids that paſs through that Cavity, goes through the Pores of Veſſels, there is nothing in this but what is confirmed by an hundred Experiments.

Now we are going to ſearch for the Place where the Senſation of Sound is performed, it is not in the Veſtibulum: For, 1*ſt*, The ſonorous Rays muſt produce Senſation in Places where they are heaped together; in the Veſtibulum they are expanded into a large Surface, and are thrown on all Sides in the Orifices they meet.

2dly, The ſix Openings in the Veſtibulum, ſhew that it is formed to conduct the Air in divers Places rather than to receive the Impreſſions, for a large part of its Surface is taken up by theſe Orifices. *3dly*, The Spire that goes to the Feneſtra Rotunda would be of no uſe; for the Vibrations which would come through that Feneſtra would meet at the Point of the Snail thoſe that would come from the Veſtibulum; thus they would produce no Effect, ſince they would return on their Stapes. *4thly*, In ſhort, the ſemicircular Canals and Snail would be of no uſe.

It is not only the Concha wherein the Senſation of Sound is formed, for it is not in Birds, who nevertheleſs hear very well, as we have already obſerved. The ſemicircular Canals are the Organ of Hearing in Birds and Fiſh, why ſhould they not be in Man?

The ſame as the Senſation of Light is formed in the Place where all the Rays are reunited, and have more force, the Senſation of ſonorous Rays is perceived in the Point where their reunion is formed, *i. e.* where they are found ſtronger. But before we ſeek this Place, we muſt obſerve that it is not neceſſary for all the Rays to reunite in the ſame Point, it is ſufficient that they be united in divers Places; for as the two Senſations at the two Ears do not multiply the Sound, thoſe that will be at different Points of the ſame Ear will not multiply it neither.

This ſuppoſed, the Principles we have eſtabliſhed in the beginning, will conduct us where the Sound is perceived. *1ſt*, The ſemicircular Canals which are open in the Veſtibulum, are each more ſtrait in the middle than at their two Orifices; ſo that the ſonorous Rays in entring through the two Sides in a Canal, muſt be reunited in the middle. 2*dly*, We have ſeen that crooked Ducts augment the Sound, it is therefore neceſſary that the ſemicircular Canals give force to the ſonorous Rays. 3*dly*, The Figure of a Snail is very proper to reunite the ſonorous Rays; the Concha will reunite them therefore at its Point where the two Spires communicate.

It is credible therefore that the Senſation of the Sound is made in the middle of the ſemicircular Ducts, and at the Point of the Snail. The Uniformity of what paſſes in all theſe Points muſt give a great deal of likelihood to what we ſay here: the Air that enters through an Orifice of the Duct, meets in the middle of the Duct that which comes through the other; in the ſame manner the Air which enters through the external Spine that bends at the Feneſtra Rotunda, meets that which comes through the internal Spire that opens in the Veſtibulum; in a word, in all the Places the Canals are crooked, and become always more ſtrait; as for the reſt, when we ſay that the Air enters, it is but to make us better underſtand there is nothing but the Motion which paſſes from one place to another.

In that part where all the ſonorous Rays are united, they make a large Impreſſion in the Nerves; it is in making this Impreſſion that they loſe their Motion; they return in the Veſtibulum with the Air which is left, but they make no Impreſſion there, for Reaſons we have alledged, and becauſe theſe Rays come from a narrow Place into a large Surface they have no more force.

To explain how our Ear perceives the diverſity of Sounds, they had recourſe to the ſpiral Lamina; but we have ſaid that Birds perceive that diverſity, ſince they learn divers Tunes; thus this ſpiral Lamina is not unneceſſary for that. But there are other Reaſons. Tunes are not formed but by the ſwiftneſs or frequency of the Vibrations; this ſwiftneſs and frequency of Vibrations will be perceived of itſelf at the auditory Nerve. But why doth not the Air alone communicate its Vibrations to the Nerves as it communicates them to the Lamina and Ducts, and as the Ducts and Lamina communicate them to the Nerves? We ſhould rather ſeek in the Nerves Cords, that were at Uniſon; but, in a word, why ſeek we there all theſe different Cords? Will not the greateſt or leaſt Swiftneſs be perceived, when the Air acts on the Nerves by Vibrations leſs or more rapidly? Beſides, the Nerves which are lax Cords and fixed to divers Points, are not ſubject to Vibrations, as we have already proved.

By what we have ſaid we may explain many Phænomena which depend on the Structure of the Ear. 1*ſt*, If we apply the hollow of the Hand to the external part of the Ear, ſo that it is towards the ſonorous Body, we hear much better, for then we gather more Rays; and thus a ſtronger Impreſſion is made in the Ear. 2*dly*, The external Ear being cut, we hear with more difficulty; this proceeds from the auditory Canal's heaping many Rays, being taken away; we might ſupply this Defect by a widened Duct to be applied to the auditory Hole. 3*dly*, If we turn the Plane of the external Ear to a ſonorous Body obliquely, in turning the Head towards the oppoſite Side, we hear much better, becauſe the auditory Duct goes forwards; thus, when we turn the Head, we receive directly the ſonorous Rays. 4thly, Hearing is much clearer, when we hearken with our Mouth open; it is poſſible that the Motion of the Air communicates then with the Ear by the Euſtachian Tube; but we muſt obſerve that the Mouth being ſhut, the inferior Maxilla compreſſes the auditory Duct a little, and by that means hinders the entrance of a Quantity of ſonorous Rays. *5thly*, When we Whiſtle, Speak, or Sing in a very acute Tune, or Yawn, we hear a ſoft Noiſe in the Ear; becauſe the Euſtachian Tube being compreſſed at divers Repetitions, the Air is puſhed on the Tympanum, and cauſes that Noiſe in falling on the Body it meets. *6thly*, There are deaf Men who hear when we talk to them in their Mouth; the Air then communicates its Vibrations through the Euſtachian Tube. *7thly*, If there happens an Obſtruction at the Euſtachian Tube, we become Deaf; the Reaſon is evident, becauſe the Tube being ſtopped, there is in the Tympanum gathered Subſtances which may extinguiſh the Sound. *8thly*, If the Membrane of the Tympanum breaks, Deafneſs enſues, although a long time after; we cannot attribute this but to the Subſtances then introduced in the Tympanum, and to the Impreſſions of the external Air. *9thly*, There have been Perſons who ſmoaked through the Ear; this Smoak entered through the Tubes, and went out at the Hole called *Hiatus Rivini*. 10*thly*, If an Inflammation enſue in the Veſtibulum, in the ſemicircular Canals, and in the Concha, the auditory Nerves would be moved by the Arteries, ſo that we ſhould hear a Noiſe, and thus it happens in pains of the Ear; the Inflammation that happens in other Places, may cauſe alſo ſome Noiſe in occaſioning divers Diſorders; as for example, in the Perioſteum that covers the Cavity of the Tympanum. 11*thly*, If the ceruminous Matter ſtopped the external auditory Duct, the Air could not communicate its Vibrations through this ſoft Matter; thus we can hear no more. 12*thly*, If there were many thick Fluids heaped in the Tympanum, the Vibrations of the Air could not communicate through the Feneſtræ; if we were to make ſome Injection through the Tube, we may take away this Matter; but if we attempt this, it muſt be through the Noſe.

Sympathetick Motions.

The Nerves are as Reins which the Soul makes uſe of to turn the Body on all Sides; the Parts owe their Motions to them only; the Branches ſent them by the ſame Trunks, or thoſe that communicate keep them in a mutual Dependence, and tranſport the Diſeaſes to one that afflict the other. Some Authors have attributed this kind of Commerce between the Parts to the Membranes which are common to them; but if there ever was an ill-grounded Opinion, this is one. Experience teaches us, that the Membranes loſe their Senſation and Action as ſoon as they have no more Communication with the Nerves; it is not therefore on them that we muſt place the Accidents that are extended from one part to the other; the Part that often ſhares the Pain of another is very diſtant, and the Parts between are not at all affected. How comes it about a Membrane that tranſports its irregular Motions ſhould cauſe any Pain in the middle? Beſide thoſe that maintain the Opinion we have mentioned, imagine that it is by

Oſcillations by which the Membranes communicate their Motions; but who would believe that Membranes preſſed ſtrongly on all Sides, fixed to each Point of their Surface, floating in an infinite Number of Places, lax almoſt every where, conducted by ſeveral Windings, ſhould be capable of Vibrations? We muſt either abandon all mechanical Ideas, or not maintain ſuch an Opinion; it is only to the Nerves and Veſſels that we muſt refer the Sympathy found between the Parts of the Body.

In divers Diſeaſes of the Brain, as in Contuſions, and Inflammations, the Eyes are inflamed; the nervous Juice propelled ſtrongly into the Nerves that run to the Eye, give a great deal of force to the Veſſels, and by that means propel the Blood into the lymphatick Arteries: the Nerves of the third, fourth and ſixth Pair, put the Muſcles into Convulſions, and the Face becomes wild, which marks that the Delirium is nigh, according to the Obſervations of Phyſicians.

Pains of the Ear are ſometimes ſo terrible, that they occaſion Death in a very ſhort time; the great Number of Branches on the ſeventh Pair, and its communication with the eighth, are the occaſion of it. As for the Tongue, Puſtulæ often enſue there, and when the Brain is corrupted we then can ſpeak no more, immediately the Nerves ſend a great deal of Fluid into the Muſcles of the Tongue, fill the Veſſels there, and hence form Puſtulæ; in a word, by the Compreſſion of the Nerves the Tongue becomes Paralytick.

In Wounds of the Head Abſceſſes happen to the Liver, and we vomit Bile; but by the Action of the Nerves that go to the Viſcus the Ducts are ſtraitened; and as the Blood has no great Motion it is heaped, filtrates more Bile, and cauſes Convulſions; but the Action of the Nerves muſt not terminate at the Liver only, it muſt be extended to other Parts; we have alſo obſerved, that in Wounds of the Head a Numbneſs was expanded over the Thigh; the Intercoſtal that goes to the Thigh explains this Phænomenon; a Gangrene that falls on a Man's large Toe after a Wound on the Head, according to *Behn*, proceeds alſo from this Nerve.

The other Parts of the Head that are out of the Cranium, have alſo more Power on the others. 1*ſt*, The Eyes receive the Nerves of the fifth Pair; thus the Dura Mater will be agitated, when the Eyes are moved; hence an Ophthalmy produces a Head-ach with Pulſations, and is a ſign of Death in Contuſions of the Head. 2*dly*, When one Eye is attacked, the other will be ſo at laſt; this may be becauſe the two Branches of the third Pair ariſe from the ſame Place. But, 3*dly*, When the Humours of the Eye flow through ſome Wound, the other diminiſhes; and this proceeds from the ſympathetick Veſſel, which communicates with both the Eyes. 4*thly*, The Eyes mark our Paſſions; this ariſes from the fifth Pair that is ſpread in the Eye and Face, and communicates with the Nerves of the Viſcera; as ſoon as there is ſome great Motion in the Brain, the nervous Juice which is ſent into the Nerves of the Eyes, impreſſes there divers Motions. 5*thly*, A Diarrhœa, according to *Hippocrates*, cures an Ophthalmia; this muſt be ſo, becauſe the filled Veſſels in the Eyes are emptied. 6*thly*, In certain Diſeaſes the Eyes are ſwelled; this proceeds from the Blood's not being able to return through the Veins; for when we tie the Jugular of a Dog, the Eye ſwells extremely. 7*thly*, Great Paſſions cauſe Inflammations in the Eye; becauſe the Nerves contracting the capillary Extremities of Arteries, the Blood being then accumulated is thrown into the lymphatick Arteries of the Eyes; beſides it is puſhed then with greater Force. 8*thly*, When the Body is deprived of Nouriſhment, the Eyes ſink; becauſe what forms their Maſs, and the fat that environs them, then diminiſhes. 9*thly*, There are many nervous Papillæ in the Eye-lids, they muſt therefore be very ſenſible; and when they are very much irritated there may enſue Convulſions in all the Body, becauſe of the Communications of the fifth Pair whence they come out.

The mutual Dependence of the Noſtrils and Diaphragm is explained by the Intercoſtal Nerve that comes from the fifth Pair, gives a Branch to the Diaphragm, and receives on each Side diaphragmatick Nerves. *Baglivi* imagined that the Noſe had ſome particular Sympathy with the Inteſtines, becauſe when we Smoke, or uſe any Tobacco in the Noſe, we are ſometimes purged; but we muſt obſerve that we ſwallow Tobacco, and ſome of it enters the Blood by Reſpiration, which is ſufficient enough to purge us; as for what regards the Brain it is not ſurprizing that certain Matters, as Hellebore, may cauſe Convulſions; the Communication of the fifth Pair with the Noſe, ſhews the Reaſon of this Phænomenon; but there is a particular Thing which happens very often, that is, we ſneeze in looking ſtedfaſtly on the Sun; this proceeds becauſe the naval Branch of the Ophthalmick gives a Branch which enters into the Skull, and goes out with the Olfactor to be expanded in the pituitary Membrane.

We have ſeen the Sympathy of the Brain with the Ears, but we muſt yet explain ſeveral Phænomena with regard to other Parts. 1*ſt*, *Wincler* ſaid, that in violently moving a Man who had a Fluxion at the Ear, he cured him of that Pain. By theſe Motions he agitated the Nerves, and ſtopped the Courſe of the Fluids. 2*dly*, *Fabricius Hildanus* ſpeaks of a Woman whoſe Pains in the Ear even extended to the Arm; he gave us the like Obſervation of a Woman who had ſomething in her Ear; this proceeds from nothing but that the *Portio Dura* communicates with the ſecond and third Vertebral that communicates with the brachial Nerves. 3*dly*, In the laſt the Pains extended to the Thighs; this could proceed from nothing but the communication of the lombal with the intercoſtal Nerves; the nervous Juice being propelled by that Nerve ſtraiten the capillary Extremities of the Veſſels; for the ſame Reaſon theſe Pains degenerate into epileptick Motions. 4*thly*, In Pains of the Ear a difficulty of ſwallowing will ſometimes enſue; this proceeds from the Nerves of the fifth Pair that go to the Tongue and communicate with the Portio Dura. 5*thly*, According to *Baglivi*'s Obſervation, Deafneſs which happens in Maladies ſtops the Courſe of the Belly; when there happens Diſorders in the Nerves of the Ear, the intercoſtal Being ſhaken ſends more nervous Juice into the Meſenterick Plexus's, and ſtraitens the capillary Extremities of the Arteries. 6*thly*, Pains of the Ear in Pleuriſies and Fevers often happen, and are a good Symptom; becauſe that the Matter that cauſed the Diſeaſe is depoſited in the parotid Glands; ſeveral Phyſicians apply actual Cauteries to theſe Glands, and this ſucceeds extremely well; this Depoſition happens, becauſe of the facility found by the Matter to be ſtopped in the Cellules of the Glands.

The Teeth have no leſs Connexion than the Ear with all the Parts of the Body. *1ſt*, The Tooth-ach cauſes a Tumour and Inflammation; this proceeds from the Nerves of the fifth Pair which go the Teeth and ſend Branches to the Cheeks, Gums, and Muſcles of the Face; thus when the Pain of the Teeth is violent, the Nerves contract the arterial Extremities, the Fulneſs formed then occaſions Inflammations, and filtrates a great deal of Fluid in the Interſtices of Fibres, either from the Gums or from the Cheeks; in a word, the ſame thing occurs as when we tie the Jugular of a Dog, *i. e.* that the neighbouring Parts are inflated. *2dly*, The Tooth-ach extends ſo far as the Ears, becauſe of the Communication of the Portio Dura with the fifth Pair. *3dly*, The Eyes ſuffer not leſs by the Tooth-ach; and, according to *Bauſner*'s Obſervation, there often ariſes a Swelling on the Eye, and the Eyelid ſeems to palpitate; the Branch that is expanded at the Teeth of the ſuperior Maxilla ſends a Branch into the Canal which is under the Orbit, and is expanded by the Teguments of the Face to the upper Lip. This Nerve being agitated, the Juice that there flows contracts the arterial Extremities under the Eye, and by that means cauſes a Tumour there: the common Origin of that Branch and Ophthalmick of *Willis*, ſhews us how much the Eye may ſuffer by the Tooth-ach. *4thly*, When the Teeth juſt come out in Children Diarrhœa's often enſue, or inſtead of them Fevers, and Vomitings: as the Nerves of the fifth Pair are very much agitated, the eighth Pair communicates with that in the Mouth, and the Intercoſtal which takes its riſe from the fifth contract different times the arterial Extremities of the Inteſtines; a Fluid may then be expreſſed that is filtrated in the Inteſtines; but if the Contraction is ſuch, that every thing be ſtopped, then the Blood being ſtopped more will cauſe Fevers and Vomitings. *5thly*, Children are troubled with epileptick Motions; the Agitation of the fifth, eighth and Intercoſtal, is the Reaſon of it; beſides, the Blood ſtopped in the Viſcera agitate on all Sides the Nerves by the divers Motions it receives from the Heart; and on this depends the Obſervation of *Hippocrates*, *viz.* that Convulſions happen not to Children who have then Diarrhœa's, for the Veſſels are emptied. *6thly*, Remedies put in the Ear cure ſometimes the Tooth-ach; this ariſes from the Communication of the fifth Pair with the Portio Dura. *7thly*, Veſicatories cure ſometimes Pains of the Teeth; it is a certain Principle that every thing being *in Equilibrium* in the human Body, all the Effort is carried towards the Place where this *Equilibrium* is interrupted; for through the Veſicatories the *Equilibrium* is interrupted in one Point, and then the Effort being carried towards that Point, it is leſs about the Teeth. *8thly*, For what regards the Connexion of the Larynx and Pharynx, the Par Vagum ſends there Branches below the Corpora Olivaria, and in running it over gives ſome to the Œſophagus and Trachea Arteria.

The Breaſt offers us as many curious Phænomena as the Head; but, I believe, there are many Facts that we attributed to Sympathy, which depend on another Cauſe. 1*ſt*, The Lungs being attacked, the intercoſtal Nerves muſt cauſe frequent Inſpirations, for on the pneumonick Plexus's, the Intercoſtal that communicates with the dorſal Nerves communicate the 8th pair. 2*dly*, The Inflammations of the Lungs occaſion Pain towards the Clavicles and Shoulder-blade, becauſe the intercoſtal Nerve forms with the ſecond dorſal Pair the Nerve that goes to the ſubclavian Muſcle. 3*dly*, The Cheeks become red in thoſe that are Phthiſicky. To explain this Phænomenon, we muſt obſerve that the Blood flows not freely in the Lungs; thus it is ſtopped in the upper Vena Cava; the Arteries muſt therefore neceſſarily be inflated, and ſend more Blood into the Face. Another Obſervation to be made, is, that the cutaneous Network is fatter on the Cheeks than any where elſe; thus the Parts dry in a Conſumption; the reſt of the Network is cloſed, and receives no more Blood; but as it is thicker at the Cheeks, it is not ſtraitened as elſewhere, and the Blood that cannot enter into the other Parts of the Network is thrown in greater Quantity on the Cheeks. 4*thly*, The Brain ſuffers in Maladies of the Lungs; this may proceed from the Communication of the eighth Pair with the fifth, which ſends Branches to the Dura Mater; but we muſt above all have regard to the Blood, which cannot deſcend from the Brain. 5*thly*, *Baglivi* tells us there is a great Connexion between the Breaſts and Teſticles, Legs and Ears, becauſe the Maladies of the Lungs are thrown into thoſe Parts; but this Accident proceeds not from the Connexion; the Matters that form an Abſceſs in the pulmonary Texture, are tranſported through all the Body through the ways of Circulation, and are depoſited in the Places where they are ſtopped, whether it be through the Diſpoſition of the Parts, or by ſome Accident; in the ſame manner Matters that are depoſited in theſe Parts may be tranſported to the Lungs where they are ſtopped becauſe of its delicate Texture. *6thly*, In applying Veſicatories to the Legs, we eaſe Pleureticks, becauſe in the Place where the Veſicatories act there is formed a Derivation, and the Fluids finding leſs reſiſtence in that Place, the depoſited Matter in the Lungs in circulating by degrees go through that Place, or is depoſited thereabouts; it is thus that Dilatation being formed in the ſalivary Glands the Saliva eſcapes continually. *7thly*, As for the Diaphragm, when it is inflamed we fall into Madneſs, which is nothing but an Inflammation of the Meninges. This proceeds from that the Diaphragm having no more Motion, the Blood is ſtopped in the Lungs, and conſequently in the Brain; beſides the diaphragmatick Nerve which communicates with the Intercoſtal, agitates the fifth Pair that ſends Branches to the Dura Mater, and muſt there conſequently fill the Veſſels. This Communication of the diaphragmatick Nerve will alſo give the Reaſon of all that which happens in the Face by the divers Motions of the Diaphragm.

Diſeaſes that happen to the Stomach extend almoſt over all the Parts. *1ſt*, The Cephalalgies, Deliria, Vertigoes, Redneſs of the Face, and ſoporous Affections depend very often upon that Viſcus; the Nerves of the Stomach being agitated, thoſe of the Kidneys, Spleen, Liver, and Meſenteric Plexus's are agitated alſo, and contract the Veſſels. The Contraction of the arterial Extremities ſtops the Blood in all its Parts; it is therefore neceſſary that the Fluids be carried in greater Quantity towards the Head, and there produce the Effects juſt mentioned. *2dly*, The Nerves that run to the Stomach ſend Branches to the Larynx, Pharynx, and to 'the Muſcles of the Os Hyoides at the Œſophagus; thus when the Stomach is agitated, the Branches will be alſo agitated, and will ſend more nervous Juice into theſe Places; the excretion alſo of the Saliva precedes a Vomiting, falſe Anginæ are cured by Purges, and the Tongue, according to *Baillou*, perceives always Diſeaſes of the Stomach. *3dly*, The Breaſt has no leſs Connection with the Stomach; we have ſeen that the eighth Pair ſend Branches to the Trachea Arteria, form the pneumonick Plexus's, and expand on the Œſophagus: we muſt not therefore be ſurprized if an Aſthma be not ſometimes only an Effect of the Stomach; if the trouble in that Viſcus excite ſtubborn Coughs; if the Pleuriſy proceeds from Worms; if the Matters that relax the Stomach are ſo ſalutary in the Inflammation of the Lungs. *4thly*, But if the Lungs are troubled by the Ventricle, the Heart is no leſs ſo; the Branches that go to the Cardiac Plexus and to the Heart, Auricles and Veſſels, muſt neceſſarily be agitated, when the Nerves of the Stomach are ſo; for they come from the eighth Pair; then the nervous Spirit will be thrown into the Heart in ſo great a Quantity, that the Heart will remain in Contraction during a long while: but this can't happen unleſs when we fall into a Syncope. *Baillou*, and other Practitioners, bring many Examples of it. *5thly*, Beſide the Connections which we have been ſpeaking of, the Stomach has alſo ſome with the Abdomen. *6thly*, The ſemilunar Plexus that forms by its Branches the ſplenick Plexus, communicates with the ſtomachick Plexus; thus when the Spleen is filled with thick Blood in Hypochondriacks, the irregular Motions which will then enſue, will communicate with the Stomach, and in ſtraitning its Pylorus they will give room to the Air to rarify and cauſe Inflations. *7thly*, The Liver will not ſuffer leſs by the irregular Motions of the Ventricle; the nervous Fibres the eighth Pair ſends to the Pylorus, are joined to the hepatick Plexus; thus when they are moved, the Bile will immediately flow. *8thly*, The ſtomachick Plexus communicates with the meſenterick Plexus's; thus Pains of the Stomach may paſs in the Inteſtines. *9thly*, The left renal Plexus communicates with the ſtomachick Plexus; thus if the Reins are inflamed, a vomiting may enſue. 10*thly*, The Vomitings of Women with Child cannot proceed from the Nerves, for it laſts not always; this proceeds from the Blood's coming from the Uterus not being able to come out, there is thrown a larger Quantity into the cæliack Artery. 11*thly*, As the Nerves of the eighth Pair that terminate almoſt at the Stomach, communicate with the Nerves which are expanded without, we ſhall not be ſurprized if the Evils that happen to the Stomach excite Sweating or ſuppreſs Tranſpiration; the great Contraction that will be cauſed then in the Veſſels will immediately expreſs the Fluids of the Strainers, and at laſt will ſtop the ſecretory Ducts.

The Inteſtines receive their Nerves from the Intercoſtals; theſe Nerves form the Cardiack Plexus, the Splenick and Venals; communicate with the dorſal Nerves, and with the Nerves of the Stomach, and ſend Branches to the Bladder, &c. Thus, 1*ſt*, In the Iliack Paſſion Syncope's will often happen by the Agitation of the Cardiack Plexus. *2dly*, Reſpiration will be difficult, becauſe the coſtal Nerves will be drawn by the Intercoſtal; beſides near the pneumonick Plexus's at each Side is inſerted at the eighth Pair a Branch of the Intercoſtal. *3dly*, We ſhall vomit becauſe of the Communication of the Meſenteric Plexus's with the Stomachick. *4thly*, There will enſue a great Flux of Bile, and perhaps an Inflammation of the Liver, becauſe the hepatick Plexus comes from the ſemilunar Plexus, that ſends Branches to form the Plexus of the Meſentery. *5thly*, The Urine will be ſtopped, becauſe the venal Plexus will ſtraiten the capillary Extremities of the venal Arteries. *6thly*, Cholicks may occaſion Cephalalgies, ſince the Blood being ſtopped in the Inteſtines, Kidneys and Liver, will be carried to the Head in a larger Quantity; this may even cauſe an Epilepſy; for if the Straitnings cauſed in the lower Parts are ſuch that the Blood cannot circulate, the Plethora's that will enſue, will cauſe ſuch Pulſations againſt the Nerves that all will enter into Convulſion; the diſorderly Motions cauſed by the inferior Nerves may alſo produce the ſame Effect in thoſe that will communicate with them; in a word, theſe Convulſions may cauſe a Palſy in the ſame manner as we ſaid an Apoplexy might. *7thly*, The nervous Juice that will then flow in a greater Quantity in the muſcular Sides of the external Veſſels, will ſtraiten the laſt Ducts; thus they will ſuppreſs Tranſpiration. *8thly*, The Cholick may change into a Gout, for the nervous Juice being ſent into the crural Nerve with force becauſe of the Agitation of the meſenteric Plexus's, the Veſſels of the Articulations will be filled.

The Liver receives its Plexus from the intercoſtal Nerve, which ſends it three Branches after that it has given one to the Diaphragm; let us ſee what ſuch an Origin muſt produce. 1*ſt*, In Inflammations of the Liver Hemorrhages happen at the right Noſtril, this ariſes from the right intercoſtal Nerves that furniſh the hepatick Plexus, communicating with the Nerves that go to the Noſe, and then occaſion there Plethora's, which are followed by an Hemorrhage. 2*dly*, Thoſe who have their Liver too large or inflamed, feel, according to *Baillou*, a Pain at the Clavicles and Shoulder-blades; we muſt obſerve, that then we reſpire not but in raiſing the Sides, and that the Diaphragm is almoſt immoveable: but better to raiſe the Sides, we keep the Shoulder-blade and Clavicle raiſed, which cannot be done ſome time without Pain. 3*dly*, Vomitings happen becauſe the Fibres of the eighth Pair that go to the Pylorus join to the hepatick Plexus. 4*thly*, *Hollier* ſays, he ſaw in his Practice two or three times in the Thigh inſupportable Pains that nothing could cure, and that he found Pus between the Muſcles, and in that Caſe the Liver had a Vomica; this Phænomenon depends not on the Nerves, perhaps the Pus of the Leg was depoſited in the Liver, or that from the Liver it came in circulating or a-croſs the cellular Subſtance till the Extremities.

We have already ſaid ſomething of the Spleen. 1*ſt*, The Diſeaſes that happen there are ſometimes felt at the right Side; this muſt happen by the Communication of the left ſemilunar Plexus with the hepatick Plexus; for it is this ſemilunal Plexus which gives riſe to the ſplenick Plexus. 2*dly*, When there is ſome Obſtruction, we are ſubject to vomiting; this proceeds from the Communication of the ſemilunar Plexus with the ſtomachick. *3dly*, Hypochondriacks have a difficulty of reſpiring; the Branches of the Intercoſtal that are joined to the dorſal Nerves, muſt cauſe this Symptom, and the intercoſtal Branch that unites at the eighth Pair near the pneumonick Plexus may ſtill contribute to this Effect, the ſame that the Union of the ſemilunar Plexus with the left Nerve of the eighth Pair. *4thly*, By the laſt Communication which we are ſpeaking of, Hypochondriacks feel a great ſtraitning at the Region of the Stomach; we muſt to this add the great Quantity of Blood that the Stomach receives becauſe of the Obſtruction of the Spleen. *5thly*, As the cardiack Plexus is formed in part by the Branches of the left Intercoſtal, we ſee that the Heart may feel Pains from the Spleen. *6thly*, We muſt perceive a great Weight, eſpecially when we have eat, for the ſtraitening cauſed by the Nerves accumulate the Blood in the Arteries, and the Spleen thus filled is preſſed by the Aliments.

There is no Part that cauſes more Diſorders than the Kidneys. *1ſt*, If there is any Stone, there enſues a difficulty of Reſpiring, becauſe of the Communication of the Intercoſtal with the Coſtal Nerves, and with the eighth Pair; beſides, that the Diaphragm may not compreſs the Kidney, we raiſe the Sides; we keep our ſelves ſtraight, as *Baillou* obſerves. From this ſame Cauſe ariſe ſometimes Pains of the ſide, which are like thoſe of the Pleuriſy. *2dly*, *Liſter* obſerves that Palpitations enſue, when we have a Stone in the Kidneys: This may happen by the frequent Contractions that the Branches of the Intercoſtal cauſe in the Heart, which form the Cardiac Plexus. *3dly*, The Pulſe is low at the diſeas'd Side: For as the Intercoſtal communicates with the Brachial Nerves, they contract the Arteries, and hinder them from obeying the Motions of the Heart. *4thly*, Colics and Vomitings enſue. The Communication of the Meſenteric and Stomachic Plexus's with the Renal Plexus's, produce theſe Accidents. *5thly*, The Teſticle retires upwards. We have attributed this to the Urethra that retires; this may be one Cauſe: But it eſpecially proceeds from the Lumbal Branches which are thrown into the Spermatic Veſſels, and that go to the Muſcle Cremaſter; the which in contracting muſt of neceſſity raiſe the Teſticle. *6thly*, We feel a numbneſs at the Thigh, becauſe of the Compreſſion of the Intercoſtal Nerve near the Kidney. *7thly*, There happens a Suppreſſion of Urine, becauſe the irritated Nerves contract the arterial Extremities of the Kidneys. *8thly*, We perceive a pain at the Loins, becauſe near the Place where the Branches of the Renal Plexus's riſe, there are Strings that are thrown to the Loins: Beſides, the Semilunar Plexus having ſent Plexus's to the Kidneys, ſends Branches to the Loins. *9thly*, The Motion of the Muſcle is ſuch as muſt incommode the diſeas'd Kidney: Thus when we rub againſt ſome place, we ſhall perceive ſome pain. *10thly*, The Pains of the one Kidney extend to the other; they are often not perceived in that which is afflicted, but in the other. The Semilunar Plexus communicates the one with the other: Thus when one Kidney is diſeaſed, the Contraction that the Plexus's will produce in the Arteries of the other, may there cauſe a Suppreſſion: But if the Stones cauſe a great Compreſſion in the Kidney, there will be no more Senſation; nevertheleſs the Diſtenſions that theſe Stones will cauſe, will draw the Nerves from the other, and will there tranſport the Pain. 11*thly*, We will ſay no more of the ſympathetick Motions that regard the Strainers of the Urine by the connexion of the Bladder with ſome Parts. 1*ſt*, When it contains a Stone, we perceive a Pain at the Glands; this ariſes from the Nerves being irritated by the Stone, which contract the tender Veſſels that are at the Glands, and there cauſe a ſeparation in the Fibres. 2*dly*, When we make Urine with pain, we feel little convulſive Motions almoſt over all the Body, becauſe the intercoſtal Nerves agitate the ſpinous Nerves that may carry their Motions in all the Parts. 3*dly*, The Bladder muſt communicate its Motion firſt to the Abdomen, becauſe it receives Nerves from the lower meſenteric Plexus; ſecondly, to the Anus, Proſtratæ, and ſeminal Veſicles; for the Nerves it receives ariſe from the Plexus we have been ſpeaking of, and from the Intercoſtal.

If ſome Part has any connexion with the others, it is in the Womb. 1*ſt*, In hyſterick Paſſions Women feel an icy cold behind the Head; the vertebral Nerves that communicate with the Intercoſtal, are ſo agitated by the laſt, that they ſend in the Coats of the Head a great Quantity of nervous Juice, and that the Veſſels are entirely ſtraitened; as the Blood cannot flow there, then the diminution of the Motion occaſions cold. 2*dly*, A great Head-ach enſues, becauſe the Blood ſtopped in the inferior Parts is carried in a greater Quantity towards the ſuperior Parts; it is hence that again depends the Dizzineſs which conſiſts not in its Origin but in the Inflation of Arteries that go to the Eye; it is ſtill to this ſame Cauſe that we muſt refer the tingling of the Ear; 3*dly*, The paleneſs in this Diſeaſe may be explained by the Swelling of the large Ducts which compreſs the ſmall, and hinder the Blood from entering there; then the large venal Trunks make the Parts livid becauſe of their Colour; and this is the Cauſe of the livid Circle under the Eye. 4*thly*, Convulſions proceed from nothing but the Blood's being ſtopped, which by its violent Motions every where agitates the nervous Courſe. 5*thly*, A large ſtraitening of the Larynx and Pharynx enſues; this ariſes from the connexion of the ſuperior gangliform Plexus of the Intercoſtal with a Branch of the eighth Pair that go to the Larynx and Pharynx. 6*thly*, The difficulty of Reſpiring proceeds from the Agitation the Intercoſtal cauſes in the Pneumonick Plexus; the Blood which is then ſtopped in the Lungs, becauſe it cannot flow towards the inferior Parts, may ſtill produce this Difficulty of reſpiring; add to all this the communication of the Diaphragmatick Nerve with the Intercoſtal, and the Branch that the left Intercoſtal ſends to the Diaphragm; all theſe Communications will be but too ſufficient to diſorder Reſpiration. 7*thly*, Vomiting may proceed from too great a Quantity of Blood in the Stomach, from the Agitation that the meſenteric Plexus's cauſe in the ſtomachic Plexus, and in the Branches of the eighth Pair; and from the Agitation of lumbal Branches that go to the Muſcles of the Abdomen. 8*thly*, The Syncope ariſes from that the cardiack Plexus's that come in part from the intercoſtal, keep the Heart in a long Contraction by the large Quantity of nervous Juice which is there ſent. 9*thly*, The Liver muſt alſo be attacked, for the hepatick Plexus is formed through the intercoſtal; thus the Vomitings will be bilious, as *Sydenham* obſerves. 10*thly*, There is often formed a Tumour in the Belly, which riſes and falls; the meſenteric Plexus's that come from the intercoſtal, communicate at laſt with that Nerve, and ſend Branches to the Womb which contract the Inteſtines; and if the Contraction begins, for example, at the End, the Air taken away is heaped up and rarefies; but this cannot be, if no Globe were formed in the Belly. 11*thly*, We ſee by what we have ſaid, that the Inteſtines may be attacked with terrible Colicks. 12*thly*, Pains of the Loins proceed from Branches that there ſend the meſenteric Plexus's and the Intercoſtal. 13*thly*, The Urine is clear as Water, becauſe the Intercoſtal being agitated, the renal Plexus's will be ſo too, then the large Quantity of nervous Juice which is propelled in the arterial Extremities of the Kidneys, cauſe there a Contraction, which permits not the large Parts to eſcape. 14*thly*, Theſe are the Phænomena that attend the hyſterick Paſſion; there are others which accompany the time of being with Child; Vomiting depends rather from the Veſſels than Nerves; for if it depended on Nerves, it would be more violent: When the Fœtus grows, the Blood which cannot be diſcharged through the Womb, is obliged to be carried in a greater Quantity into the Stomach, and there cauſe vomiting. 15*thly*, Women with Child feel Pains at the Thighs when they fall on their Knees; this proceeds from the round Ligament's being drawn. There are ſome who would fall in Fits, if they remained long on their Knees. As the Abdomen is then much preſſed, the Diaphragm cannot deſcend, and conſequently Reſpiration cannot be performed. 16*thly*, The Bladder, Rectum and Womb receive Nerves from the ſame Trunks; we ſhall not be therefore ſurprized if theſe Parts diſtinguiſh Maladies from one another.

FINIS.

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